Model Development and Exploration into the Driving Decisions of Older Adults

by

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Abstract

With advanced age, declines in physical and/or cognitive abilities make driving more difficult, and challenge the individual to make decisions about their driving. The main aim of this research was to explore how older adults make day-to-day decisions about driving, and how others' opinions influence them. This thesis addresses major gaps in the published literature on older driver decision processes, and how these processes differ across gender and habit strength for driving. An integrative mixed methods approach was used to study a convenience sample of 37 urban dwelling drivers, age 70 years and older.

This exploratory research reveals that decisions about driving are dependent upon at least three main features: 1) interpretation of the driving environment; 2) types of information used and decision processes employed; and 3) influence other's opinions on driving decisions.

Main findings are that older drivers evaluate their driving experience using three distinct components: 1) the driving environment; 2) people who drive; and 3) crashes. In the decision-making process, older drivers are characterized by their dynamic use of information wherein an item may be used to support the decision to drive some instances, but in other instances used in choices not to drive. Three categories of items are identified in a proposed Older Driver Decision Components Framework, and reflect this dynamic process: Motivators, Constraints/Motivators, and Context. Additionally, three groups of older drivers are identified based on their driving choices, and defined by characteristics such as gender, age, and habit for driving. Responses to comments about their driving also help define these groups.

Results of the study provide a new direction for research on the older driver, and models are developed that may be used to form a basis for understanding older driver decision-making. Refinement of our knowledge about how elders assess their driving environment, and the subsequent choices they make, should be pursued to better understand how they adjust their transportation needs and desires to age-related changes. In turn, this knowledge may be used to design programs and policies to support the safe driving of our aging population.

Keywords: older driver decision-making; driving habit; driving self-regulation; information preferences; driving cessation; family influence on driving

Dedication

For Alyssa and Blair, my greatest accomplishments, who make this thesis seem pale in comparison.

For my dearest friends, who have walked beside me for this long academic journey: Bruce, who continually challenges my intellect and brings me back to reality with laughter; and Debra, whose words, “How do you eat an elephant? One bite at a time!” became my mantra for completing this work.

And especially for Brent, for his infinite patience, understanding, support, love, and pride in me, even with all the scrapes and bruises of my imperfections. Without you the joys of success would never be as sweet.

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My gratitude and warmest thoughts also go to the amazing people who selflessly subjected themselves to this research, and made it so much fun. Without the generosity of your time and inner reflections, this work would not have been possible.

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List of Acronyms

ADL	Activities of daily living
BDT	Behavioural Decision Theory
DCE	Discrete choice experiment
MDS	Multidimensional scaling
MET	Microeconomic Theory
MIRS	Modified Interpersonal Relationship Scale
MMSE	Mini Mental State Exam
P-E Fit	Person-Environment Fit
SPSS©	Statistics Package for Social Sciences ©
SRHI	Self-Reported Habit Index
SRK	Skills-Rules-Knowledge
TUG	Timed Up and Go

Preface

"You're studying older drivers? Let me tell you about my grandfather….."

We often dedicate our energies to studying things that impact us emotionally as well as intellectually. My journey towards completing this work began with the story of my own aging father and the impact his driving had on him and on his family. His story, as I was eventually to learn, was similar to many others of his generation where his strong sense of obligation and self-worth in providing family transportation was eventually challenged by the damages inflicted by Alzheimer's disease. His internal battles with making decisions about his driving were surpassed only by his battles with his family, his physician, the motor vehicle branch, and the local police. His car was like a best friend to him, bringing all of the benefits so commonly acknowledged by older drivers: comfort, sense of purpose, independence, power and control, companionship, reliability…Its eventual loss was something he never fully accepted.

The work presented in this dissertation is the product of my own struggles to understand what is at the heart of decisions made by aging drivers. If there is one thing that I have learned, it is that decisions about driving are important to both drivers and their families alike, and that they are influenced by emotion as much as by rational thought, rendering them less predictable than logic would dictate. Through the research presented here, I have tried to provide some organization to this highly complex topic, with the hopes of enabling a better understanding of what drives these important decisions. I consider this work a beginning.

I have spent many hours talking with older drivers and their families, have enjoyed every minute, and am deeply appreciative of what they have shared. I hope this work will honour their contribution and, at the very least, provide a stepping stone to supporting continued safe mobility.

Chapter 1. **INTRODUCTION**

The ability to move from one place to another is essential for human development and the maintenance of quality of life, thus choices related to mobility are some of the most prominent decisions made in day-to-day life. Without mobility, individuals are dependent upon others to provide access to life choices, restricting the options and opportunities that individuals might otherwise seek for themselves. Mobility affords a means of accessing basic needs fundamental to day-to-day living such as shopping and medical appointments, as well as exploring individual desires. It allows individuals to experience different environments and enrich their lives through learning. It supports a wider range of human interactions, and provides access to healthy lifestyle activities. Throughout most of our lives, it is taken for granted that at least relatively short distance mobility is feasible, and travel decisions are made without much presupposition. However, for virtually everyone, there comes a time when advanced age challenges mobility, and therefore the choices made about how to get from one place to another become more onerous. This thesis addresses how driving choices are made among older adults, and what factors influence these choices.

With advanced age, many individuals experience declines in physical and/or cognitive abilities that make driving a vehicle more difficult. Decreases in neck mobility, for example, make it harder to shoulder check when changing lanes, and declines in memory may make it more difficult for route planning and quick decision-making. Such changes can increase the aging individual's risk of causing a crash. We know that in advanced age many elders drive fewer kilometers and avoid certain driving situations such as bad weather and night-time driving, although the motivations for doing so are not always related to declining functional abilities (Molnar, Eby, Charlton et al., 2013). We also know that they will sometimes accept rides from others but that they rarely see public transportation as a viable alternative to car travel (Handy et al., 2005). However, relatively little is known about how individuals arrive at such decisions. The literature on how elders

adjust or self-regulate their driving is fragmented and has produced conflicting results. A better understanding of what factors are considered when an individual decides, for example, to accept a ride from another person, and under what conditions various factors are considered in this decision, could be helpful in arriving at a shared understanding of older adults' patterns of driving behaviour. In turn, an improved understanding will be useful in developing programs to support elders to meet their transportation needs.

1.1. Importance of Driving

The private automobile has developed into the most efficient facilitator of mobility available to the individual. No other means of transportation can provide such speed and flexibility of travel, allowing freedom, independence, and self-reliance. By being able to drive, the individual needs no dependency on others, travelling virtually anywhere at any time. A car provides many benefits not provided by other means of transportation: mobility in a physically comfortable environment protected from the weather; freedom to navigate around obstructions at will; the ability to transcend distances quickly; the ability to transport a large amount of goods; and a socially comfortable environment in which to transport and interact with other people. But the car provides even more than just an efficient means of transportation. Besides its functional status, the private automobile is available in a wide variety of colours, designs, and options (at a range of price points), allowing the individual to express their personal style, values, and status. It is little wonder that cars have become so deeply entrenched in the North American culture, and that driving now persists well into old age.

Driving has become a fundamental lifestyle activity in our culture, and is the preferred mode of transportation for most elders in Canada (Gwyther & Holland, 2015). As young people mature and strive for independence, transportation for instrumental and social events becomes increasingly important. Many teens plan for the day when they are old enough to get a driver's license and can make choices of when and where to participate in events. At the other end of the lifespan, however, most older drivers do not plan for a time when they will need to stop driving and use alternate transportation, even though they acknowledge that such a time may eventually arise (Musselwhite & Shergold, 2013). Older drivers concede that age is often accompanied by declines in vision, reflexes,

and other capacities that affect driving, and they notice these changes in others. Yet they are strongly reluctant to give up their own car keys. Instead, they choose to continue driving for as long as possible, although some choose to restrict the amount and type of driving they do, avoiding heavy traffic or left-hand turns, for example. In fact, the attachment to driving is so profound that in many older adults the loss of driving privileges leads to depressive symptoms, physical decline, and earlier institutionalization (Azad et al., 2002).

Independence and self-determination are highly praised values in North American culture and contribute substantially to perceptions of quality of life. Integral to independence is the ability to make personal choices without having to be dependent upon others to help realize those choices. One of the primary concerns of aging individuals who are experiencing physical and/or cognitive declines is that they will become dependent upon others. This concern is twofold: that their dependency will restrict their personal lifestyle choices, and also that they will become a burden to their families (Connell et al., 2013). Issues of mobility and transportation are particularly relevant in this regard. Unfortunately, functional declines that affect driving abilities also limit access to other forms of transport such as walking, cycling and public transportation, further threatening the range of personal choices available to maintain quality of life. The decision of whether or not to continue driving thus becomes synonymous with quality of life itself, and increases in importance with age-related declines.

1.2. Gaps in Driving Decision Research

Although aging adults face frequent transportation needs, relatively little is known about why and how they make choices concerning their driving. The literature on older drivers has focused mainly on their safety as drivers, especially on how physical and cognitive changes affect driving errors and crash risk (De Raedt & Ponjaert-Kristoffersen, 2000; Wild & Cotrell, 2003). Research has also highlighted the impact of mild cognitive impairment (O'Connor, Edwards & Bannon, 2013; Snelgrove, 2005) and Alzheimer's disease (Adler, 2003; Carr, Shead & Storandt, 2005) on crash risk and self-rated driving abilities, but less is known about how individuals without cognitive challenges use

information in day-to-day driving decisions. The current study attempts to address these gaps in the literature, including the role of habit, and self-regulation.

The Role of Habit

The role of habit in driving decisions has been largely ignored in older driver research. A habit is a very repetitive behaviour wherein individuals re-use past solutions to make problem solving easier. Past transportation problems for most individuals are solved by driving, so that eventually, this repeated process constructs car travel as a habit (Nakanishi & Black, 2016). For example, the problem of carrying groceries is first solved by driving, then repeated because it is successful, so that over time the behaviour of driving each week when groceries are needed becomes a habit. However, as individuals age their life circumstances change, including the nature of the transportation problems as well as the solutions. For instance, the individual may move to an assisted living situation that provides meals, eliminating the problem of carrying large amounts of groceries. The habit of driving weekly for groceries is thus eliminated. However, remaining all day in the assisted living complex may create a new problem for the individual, namely satisfying the need to connect with the community or just to “get out”. The elder may continue to drive to the grocery store regularly, reportedly “to pick up a few items”. But in reality, this continuation of driving habit may serve primarily to maintain psychosocial rather than instrumental reasons. In other words, the strong habitual driving patterns of some elders may modify the impacts of changing circumstances on driving decisions.

The circumstances that affect the habits and behaviours of older drivers are imperfectly understood. In some studies of older drivers, issues such as employment, health, and social interactions are believed to affect driving decisions, although the relative importance of each of these factors for various groups of individuals is not clear (Molnar, Eby, Charlton et al., 2013). In particular, although the research recognizes that some individuals have strong habits for driving, it is not clear how different habit strengths affect the impacts of changing life circumstances on those habits (Raitanen, Tormakangas, Mollenkopf & Marcellini, 2003).

Driving Self-regulation

Perhaps the greatest contribution to our knowledge about driving decisions can be found in the literature on driving self-regulation, but gaps in understanding still exist. Studies have noted that decisions to avoid certain driving situations are influenced by numerous factors, for example cognitive status (e.g., Devlin & McGilvray, 2016), driving comfort (Blanchard & Myers, 2010; Meng & Siren, 2015), age, gender, vision, mood (Davis et al., 2016; Meng & Siren, 2015), and health (Carmel, Rechavi & Ben-Moshe, 2014) as well as availability of alternatives (Bird, Freund, Fortinsky et al., 2016) and feedback from others about their driving (Hassan, King & Watt, 2015). However, the priority and interrelationships between these factors, that is, the relative importance of each, and how they interact to influence decisions, is still largely unknown.

Since self-regulation involves behaviour change, it is believed to include conscious decision making (Prochaska, 2008). Self-regulation has been defined as, "compensation for age-related declines in abilities by reducing their annual mileage as well as regulating when and where they drive" (Dobbs & Dobbs, 2001). Older drivers have reported that they make driving decisions in response to age-related changes; however, it is suspected that other factors may trigger a shift from routine (habitual) to conscious travel choices. Molnar, Eby, Zhang and colleagues (2015) compiled a synthesis of the literature and found that older individuals typically reduce the amount of driving they do by 40%. However, it is unclear whether this reduction is a function of changes in lifestyle, or whether it results from decisions associated with declining physical or cognitive health (Donforino, D'Ambrosio, Coughlin & Mohyde, 2009).

Most studies of self-regulation have simply asked older drivers if they modify their driving by avoiding, for example, driving at night, during rush hour, or driving through complex intersections. Research has revealed that, at least for some drivers, there is a correlation between self-reported avoidance of difficult driving situations and driving abilities, determined by on-road driving test scores (Baldock, Mathias, McLean & Burdt, 2006), and on-road driving observation (Koppel, Charlton, Langford et al., 2016). This indicates that some elders use relevant information in their decisions about when and where to drive. Conversely, in a one-year study using instrumented vehicles (Smith, Porter, Cull et al., 2016), it was revealed that although older drivers slightly decreased

their trip distance during winter, night-time driving distances were 30% greater and there was a 5% increase in distances travelled during rain. Interestingly, the sample of older drivers did not change their driving trips during snow or vision-obstructing precipitation. The authors did not examine reasons for travel, however they suggest that, “an older driver might choose to make longer trips even if the weather were poor or if it were night, in order to maintain their community mobility.” Thus, while research suggests that driving decisions related to self-regulation involve some degree of avoidance, we know little about the mechanisms of these decisions, and in particular, what factors are considered relevant or how an individual arrives at a decision to self-regulate.

Driving Cessation

Studies on driving cessation highlight inconsistencies of how elders make decisions about their driving, leading to questions about why different decisions are made. Although medical conditions are known to affect driving abilities, it has been found that some elders continue to drive in their usual manner while others give up their car keys, suggesting there are individual differences in circumstances, or in how individuals interpret circumstances, that affect decisions. For example, the literature on older drivers highlights the impact of rural versus urban residence on continued driving, noting the higher importance rural elders attach to driving and lack of alternatives in their decisions (Thompson, Baldock, Mathias & Wunderitz, 2013). Differences between genders also suggest men and women make decisions based on different types of information. Women have been found to be more likely to cease driving due to medical conditions than men (Dit Asse, Fabrigoule, Helmer et al., 2014), and it has been suggested that these differences can be attributed to different gender roles (Choi, Adams & Kahana, 2013). From a functional performance perspective, studies have found men with low global cognitive skills were more likely to stop driving; however, women were more likely to stop due to increased reaction time and slowed cognitive processing speeds (Choi, Mezuk, Lohman et al., 2014). Some healthy older women, despite having intact driving skills, stop driving sooner than necessary (Oxley, Chalton, Fildes et al., 2004; Stutts, Wilkins, Reinhurt et al., 2001) while the same is not generally found for men. Such differences highlight the need to better understand what information individuals use in making their driving decisions.

The literature on older drivers lists numerous reasons why elders restrict or stop driving but it is not clear how, on a day-to-day basis, they use this information in their decisions. For example, several studies have highlighted reduced confidence or comfort while driving as a main decision component (Myers, Paradis & Blanchard, 2008; Blanchard & Myers, 2010; Meng & Siren, 2015). Less is known about the conditions under which discomfort plays a role in driving decisions. For example, it is not known whether different types of discomfort can be identified, whether discomfort is a stable construct, or whether there are different sources of discomfort for the individual engaged in driving tasks. Furthermore, little is known about what personal and environmental information contributes to an individual's evaluation of driving confidence at any given time. It might be assumed that involvement in a crash, for instance, could affect driving confidence and the decision to reduce or stop driving. However, while elders often say they will stop driving if they have a crash, a study that followed 132 older drivers after they had been hospitalised following a crash revealed that only 4% had stopped driving six months after the accident (Richmond, Flannigan, Betz & Platts-Mills, 2015). Instead of stopping, some elders use strategies that may improve their confidence and prolong their decisions to drive, for example, using a co-pilot (Shua-Haim, Shua-Haim & Gross, 1999), and taking refresher driving classes (Nasvadi, 2007; Tuokko, McGee, Gabriel & Rhodes, 2003). Why some elders weigh crash involvement heavily in their decisions while others do not deserves further exploration.

In summary, although the research on older drivers has documented changes in driving behaviours associated with aging, the evidence is somewhat fragmented, producing an incomplete picture of decision-making, self-regulation and cessation. In particular, the literature on older drivers does not clarify how elders use information about their abilities, the driving environment, or other factors that result in changes to driving habits. It also does not explain the mechanisms by which driving decisions are made as aging-related changes occur.

1.2.1. Models of Driving

In research, program planning, and evaluation, models are often developed to describe and understand how things really work. Whereas a theory is directed as a generalized statement aimed at explaining a phenomenon, a model is a purposeful representation of reality that provides a helpful tool to understand specific phenomena. Some models have aided our understanding of older drivers but they fall short in fully explaining older driver decisions. In particular, earlier models of traffic safety focused primarily on the causes of crashes and did not adequately consider driving behaviour. The emphasis was on identifying relatively stable traits such as vision, reaction time, and psychological attributes. However, empirical studies have failed to provide strong correlations between these traits and accident causation, primarily because they did not consider how drivers compensate for their deficiencies. In addition, since aging is typically accompanied by declines, these models were not easily applied to the aging population.

Models about information processing began to emerge in the late 1950s to better understand the complexity of multi-tasking situations such as driving, but again they were not specific to aging. In the late 1970s an important shift in focus occurred, moving away from determining the limits of information processing and towards determining characteristics and conditions under which automatic processing occurs. Schneider and Shiffrin (1977) introduced a theory to explain why people develop and rely on habits. The theory explains that virtually all behaviours include two components, namely *controlled processing* and *automatic processing*. Automation of tasks reduces the mental workload of performing tasks. This automation approach is particularly relevant for the aged with declines in cognitive domains such as working memory and divided attention because it reduces the mental workload of the individual. Observing the driving decisions of elders through the lens of this theory gives a much better understanding of how elders may rely on automatic processing versus controlled processing, and from there develop models about what information may consciously be used in decisions.

In the late 1980s, hierarchical control models evolved, recognizing the dynamic relationships between the many concurrent tasks of driving. Rasmussen's (1983) SRK (Skill-Rule-Knowledge) model differentiates between *skill-based*, *rule-based* and *knowledge-based* behaviour, and also incorporates the concept of automaticity. Michon

(1985) presented a different hierarchical structure of driving behaviour focused on driving tasks with three interdependent levels of decision-making: *strategic* (e.g., trip planning, costs), *maneuvering* (e.g., judgment of traffic situations), and *operational* (e.g., steering, braking). Michon's model provides us with a more comprehensive framework for examining driving decisions. It makes us more aware that decisions which occur within different contexts may have very different processes and outcomes. In this model, motivational factors and compensatory behaviour are suggested to influence performance. Behaviour at all levels are presumed to become highly automatic, however changes in motivation created by unexpected situations prompt a shift to controlled processing. The model predicts that drivers who rely on habit do not function well in unpredictable situations, contributing to crashes. However, like other models that precede it, the SRK model falls short of explaining the processes engaged in by the individual.

The advancement of computer simulation has resulted in new driving models that describe and predict driving. Models on specific types of driving behaviour are generally mathematical models developed from an external, observation perspective including, for example, decisions about lane changing (Mordipor, Sarvi & Rose, 2010) and braking (Shang, Peng & Lu, 2011). Although they increase our knowledge about the outcomes of driving decisions such as choice of speed and routes taken, they do not add information about how decisions are made, or even about motivations behind decisions. Other models on transportation demand (e.g., Ben-Akiva, 2008) and tourism destinations (e.g., Dunne, Flanagan & Buckley, 2011) provide some insight into motivations for travel but offer little information about daily driving behaviours.

These gaps in the literature provides the rationale for this dissertation. Decision models, built from the perspective of the driver, could add value to understanding driver behaviour and could be used to guide future research about older driver travel patterns and behaviours. Comprehensive models on driving decision-making are conspicuously absent from the literature. However, three previous models that focus on older drivers are worth noting. Anstey, Wood, Lord and Walker (2005) reviewed the literature on older drivers and outlined an Enabling Driving Competence model, a "multifactorial model for enabling driving safety". In this model, "capacity to drive safely" is separated from "driving behaviour", reflecting the view that cognitive, sensory, and physical variables determine

an individual's capacity, but that the individual's insight into one's driving capacity determines or mediates the choices that are made about driving behaviour and driving safety. This model identifies important medico-physical factors that contribute to age-related driving risk, however it does not account for the influence of other factors such as attitudes or social influences on driving behaviour. Further, the model does not address how the individual integrates different types of information, nor how the individual may compensate for changes in cognition, vision, and physical function to alter their "capacity to drive". The Driving as an Everyday Competence (DEC) model (Lindstrom-Forneri, Tuokko, Garrett & Molnar, 2010) adds contextual factors such as social, attitudinal, emotional and policy dimensions that are missing in Anstey's model. However, this model also fails to explain the processes that link the components, or the relative importance of the components. Further, the DEC model aims to explain the individual's competence or capability for driving that results from person-environment interaction – it does not consider how decisions about competence contribute to actual behaviours.

A third model, proposed by Wong, Smith Sullivan & Allan (2016) focuses specifically on older driver self-regulation. The Multilevel Older Persons Transportation and Road Safety Model (MOTRS) is a hierarchical model consisting of four levels: sociodemographic variables, driving-specific variables, psychosocial variables, and self-regulatory driving behaviours. It describes how sociodemographic factors and driving-specific factors influence older adult's self-regulation through psychosocial influences. The sociodemographic and driving-specific factors are further delineated into individual and environmental components said to be interpreted through the psychosocial factors to affect the salience of individual factors. Although the authors refer to "bidirectional pathways", the model illustrates unidirectional flow beginning with environmental sociodemographic factors and terminating in self-regulatory driving behaviours. Although this model improves on others in expanding on the factors included in driver decisions, it still does not adequately describe the process through which elders make decisions that ultimately self-regulate their driving.

Weaknesses in the MOTRS model may have resulted from the processes used in its development. The MOTRS model was built on a search of the published literature, identifying factors associated with drivers who report they self-regulate. Development of

the MOTRS model thus followed a deductive approach, assuming behaviours such as reduced mileage are self-regulation in response to age-related resource declines. This assumption may not be valid. In fact, the authors note that variations in the definition of self-regulation is a major contributor to the wide variability of reported incidence in different studies. Furthermore, the use of information only from studies that included odds ratios, or correlations between factors and self-regulation, may have failed to capture important factors in the model. An inductive approach that begins with the individual's driving decisions, and include all factors, may yield a more accurate model.

1.3. Research Purpose

This dissertation research is inspired by a desire to understand more about the risks that elders are willing to accept in order to fulfill their transportation needs. Driving is an inherently risky behaviour, and it becomes even more risky as people age. Understanding how people make decisions about driving therefore seemed to be a fundamental issue in understanding why elders are over-represented in crashes. It may be assumed that if older individuals adequately compensate for their reduced abilities, then their crash rate should be equal to that of the best drivers, especially given their vast experience. But this is not the case. Instead, drivers over age 70 have some of the highest crash rates per kilometer driven (Evans, 2000), suggesting they make less than adequate decisions about their driving risk.

The present research takes an exploratory approach to improving our understanding of decisions about driving among older adults. It is understood that elders sometimes self-regulate by avoiding specific driving situations, but we are less knowledgeable about how this process actually works. We acknowledge some key factors that might be included in driving decisions such as health, time of day, habit, need for social interaction, and social attitudes, but we do not have a good understanding of how these factors contribute to daily driving decisions. Few studies have been found that document how elders 'think through' their decisions, how (or if) they consider different information, the sources of that information, and what information is chosen as the most relevant in making a final choice about whether to drive in a particular situation, including

environmental, sociodemographic, and psychosocial influences. The present research is undertaken to initiate the exploration into this new area of research. It is assumed that how people think and arrive at decisions is a very complex task, and that trying to understand the complexities of this task cannot be accomplished in a single study. This research has been constructed to represent a starting point in trying to define decision-making processes, and differences in decision-making processes among a cohort of elder drivers.

The purpose of this research, therefore, is to explore beyond our current knowledge of age-related factors that impact driving and self-regulation, to develop a better understanding of how elders use this information in their decisions. To this end, the purpose of this research is to increase our understanding of:

1) The criteria elders use to evaluate their driving environment

2) The types of information elders use in their decisions about whether or not to drive

3) The role of habit in the driving decisions of aging drivers

4) The influence that others' comments about driving have on their decisions

The exploratory nature of this study employs primarily a qualitative approach to uncover new ideas about older driver decisions. Some quantitative methods are also included, but primarily for the purposes of proposing categorizations that could be tested in future work. In other words, this research does not set out with a set of hypotheses to prove or disprove, but instead starts with a number of questions about how elders make decisions about their driving. The three main questions are:

1. What meanings do older drivers attach to the driving environment?
2. How do elders make decisions about when and if they will drive?
3. What psychosocial influences affect these driving decisions of elders?

1.4. Importance of this Research

Understanding how day-to-day transportation decisions are made by aging adults is important to inform policies and programs supporting this unique demographic. On the one hand, driving is associated with independence and quality of life for seniors so it would seem prudent to support elders to continue driving when it is safe to do so (Mazer, Laliberte, Hunt et al., 2016). Educational programs such as 55 Alive have been developed with this goal in mind (Bédard, Porter, Marshall & Polgar, 2005; Carr, 2003; Nasvadi & Vavrik, 2007; Owsley, McGwin, Philips et al., 2004). On the other hand, the crash rate per kilometer driven increases substantially with age so that it also seems logical that policies and programs should be developed to encourage driving cessation. In fact, policies such as graduated de-licensing (Nasvadi & Wister, 2009) and programs such as support groups for former drivers (Dobbs, Harper & Wood, 2009; Liddle et al., 2013) and on-demand transportation (Nasvadi & Wister, 2006) have attempted to address this issue. However, decisions about driving generally rest with the individual with the result that attendance at support programs would be self-selective. Thus, a better understanding of how driving decisions are made could enhance the development, and especially the implementation of both driving continuance and driving cessation programs, where appropriate. A better understanding of factors that influence driving decisions for elders could also improve policy development and compliance.

For example, on a per-kilometer distance travelled we know that older adults have increased risk of causing a crash compared to middle-aged drivers (Loughran & Seabury, 2007). We also know that medical conditions such as heart disease and diabetes are associated with increased crashes among elders (Ronna, Thiese, Ott et al., 2016; Signorovitch, Macaulay, Diener et al., 2013). Possibly, individuals causing these crashes have not included their relevant health information in making decisions to drive, but have instead driven out of habit or used other information in their decisions, contributing to driving hazards on the roadways. Incorporation of salient information is essential not only to make driving decisions *per se*, but also to make health decisions that affect driving abilities, such as medication use or involvement in exercise programs to improve health. In their 2007 study, Tuokko, Rhodes and Dean (2007) found that the symptoms of poor health, such as limited strength, lack of feeling, and stiffness, were more predictive of

driving difficulties than medical diagnoses of health conditions. In a subsequent study, Tuokko, Sukhawathanakul, Walzak et al (2016) found that only health-related symptoms were significantly related to changes in driving behaviour. Similarly, Dit Asse et al. (2014) reported that fear of falling was associated with driving restriction in women. Such findings suggest that symptom information may be used in driving decisions, whereas information on medical diagnoses and overall perceptions of health may not.

Understanding what information triggers awareness of the need to make driving decisions, and how elders use information to make their decisions, will help us design programs to encourage better choices. This, in turn, will help mitigate risk, both of injury from automobile crashes and of injury associated with social and instrumental isolation (Edwards, Lunsman, Perkins et al., 2009). This is especially relevant given the expected increase in the number of elderly drivers among the Baby Boomer cohort. In the absence of effective decision support programs, driving administrators may feel obligated to develop unnecessarily stringent driving restriction policies to mitigate increasing crashes. Furthermore, in the absence of effective driving decision support programs, health care administrators may be faced with rising demands for transportation support systems among elders who have given up driving prematurely, or for those who have lost their license following involvement in a crash.

Chapter 2. THEORETICAL BACKGROUND

Two main theoretical frameworks will be integrated in the proposed research: 1) behavioural decision theory and 2) ecological models.

The main focus of this research is on how individuals make decisions about whether or not to drive. For a better understanding of the actual decision-making processes around travel choice, theories dealing with decision-making are most relevant. In this realm, microeconomic theory has provided a cornerstone for the development of transportation demand models, building on the principle of utility maximization. However, the limitations of this theory have been well documented and Behavioural Decision Theory (BDT) is now recognized as providing more relevant contributions to complex travel choices.

Decision-making broadly refers to the consciousness of an individual to make a decision, through the act of selecting an alternative from a group of alternatives (Takemura, 2014). Central to early theories on decision-making is the notion that humans approach decisions in a rational manner, objectively weighing the pros and cons of each alternative to arrive at the best choice to maximize their gains (Tversky & Kahneman, 1974). Decisions were modeled according to mathematical models of probability. However, numerous studies have demonstrated that humans do not always behave in rational ways and do not always maximize their gains. Simon (1955) recognized that individuals are “bounded” in their decisions by limitations from the environment as well as from within, resulting in incomplete access to all relevant information. The study of decisions thus began to move away from modelling decision-making as mathematical probabilities, towards studying decision-making by observing the actual decisions; Behavioral Decision Theory (BDT) describes how individuals actually make decisions in relation to the current situation, rather than how they ought to make decisions if they were conforming to the axioms of rational choice (Garling et al., 1998). Three main areas of research in BDT have been to identify violations of rational choice, to document decision rules used in making choices, and to uncover the stopping strategies used in deciding when to stop looking for more information in making decisions (Maguire & Albright, 2005).

The current research is therefore guided by BDT, which describes the process of decision-making as an activity of examining alternatives in relation to the status quo. Accordingly, transportation decisions made by older adults would be made in relation to their usual, or most habitual form of transport – in most cases, driving.

It should be noted that this research focuses on the decision-making processes of older drivers as they choose to modify their driving; it does not directly observe actual driving behaviours. A major underlying assumption in this work is that decisions made by individuals would lead directly to actions. The Theory of Planned Behaviour (Ajzen, 1985) outlines how intentions predict behaviours. For the purposes of this research, the decisions stated by participants are conceptualized as intentions and it is assumed that under natural conditions, such decisions would predict actions. For example, if a decision to drive to the store is made, it is assumed that the decision represents an intention and that it will be immediately followed by the action of driving to the store.

Behavioral Decision Theory incorporates the contribution of context in decision-making. Ecological theory is therefore also relevant to the current research in supplying a framework for understanding the context within which drivers make decisions. Ecological theory is comprised of a family of theories that addresses how aging individuals interact with physical environments in studies of, for example, aging in place (e.g., Cutchin, 2003), where the individual is challenged with attempting to retain an activity in the face of declining resources. In the current research, it is helpful to understand that the personal resources of the individual (ability to drive) must be balanced with the pressures of the environment (roadway) for positive outcomes (safe driving) to occur. This research does not directly measure the personal resources of the individual (e.g., driving skills) or the driving environment (e.g., roadway complexity) – evaluating these two components are beyond the scope of this project. Nonetheless, the principles of ecological theory underlie the current work in that the individual's perception of the balance between their personal resources and the driving environment are believed to influence driving decisions.

To assist the reader in interpreting the findings of this study, brief summaries of ecological models and decision theories follow.

2.1.1. Behavioural Decision Theory

Behavioural Decision Theory (BDT) refers to an empirical and descriptive approach to the study of human decision-making with the goal of describing and understanding how people actually make decisions (Garling, Laitila & Westin, 1998, Chapter 1; Garling, Eek, Loukopoulos, et al., 2002; Takemura, 2014). It proposes that a good decision is a choice of an action which meets the decision maker's objectives, and asks why human decisions are frequently inconsistent with predictions from other theories. Although BDT has been rarely applied to travel choice modelling, it has been extensively used in other fields such as consumer research, marketing, management science, and economics (Morton & Fasolo, 2009; Bhasin, 2016). Its application to transportation decisions is supported by leaders in this field of study (Garling & Axhausen, 2003; Verplanken, Walker, Davis & Jurasek, 2008), and is considered appropriate for the current study that examines the actual decision-making of individuals. Other decision theories commonly used to model transportation choice have proven inadequate, as described below.

In the past, Microeconomic Theory (MET) provided the major theoretical foundation for modeling travel choice (Ben-Akiva & Lerman, 1985). MET focuses on the behaviour of agents at the individual level, and is based on the assumption that individual agents behave economically and rationally, making choices which lead to the consequences that will maximize their utility. In this theory, the decision-maker is seen as facing a choice between a set of alternatives, each with a set of consequences that can be measured in some units of utility, so that the decision-maker evaluates the differences and chooses the best alternative. According to this classic utility theory approach, an individual in need of transportation would consciously consider each transportation option, for example, walking, cycling, driving, public transit and so on. For each of these, the individual would consider the consequences of each, such as convenience, comfort, risk of injury, et cetera. An evaluation process would be included wherein the individual would assign a weight or level of importance to each factor, tabulate the results for each mode of transport, and finally choose the alternative with the highest score. However, in numerous experiments utility theory has failed to explain the choices of individuals.

Utility theory is based on the definition of utility as the ability of a good or service to satisfy the needs and wants of a consumer. But it fails to tell us how people interpret their situation or identify “the best” goal. It does not acknowledge that different interpretations of situations, and hence different goals, are often possible. Utility cannot be observed. Psychologists have argued that people’s perception and evaluation of outcomes is importantly affected by a reference position, which may be the previous situation (the status quo), or some new variation in the way the issue is framed (Hodgson, 2012). For example, in meeting transportation needs the status quo may be driving, but a sudden illness might introduce a new frame of reference for transportation mode. Action is the result of choice among alternatives, and choice reflects values and individual preferences among alternatives. Utility theory assumes the individual’s preference scale remains constant over time, but there is no reason whatever for making any such assumption. All we can say is that an action, at a specific point of time, reveals part of a man’s preference scale *at that time*. Therefore, day-to-day decisions on the same goal may vary considerably. The general issue of how far actual behavior departs from the rationality assumed in conventional economic theory likely depends on the context in which the choice is being made.

One common concern with expected utility theory is that there are dozens of experimental results showing that people’s behavior often violates the axioms. In reality people do not make the calculation to see which choice has the best outcome, probably because performing the calculation of expected utility exceeds the capabilities of intuitive computation, even in simple problems (von Neumann & Morgenstern, 1947, p199). Utility theory treats uncertainty as objective risk, that is, as a series of coin flips where the probabilities are objectively known. For individuals making decisions, it is hard to place an objective probability on items, for example, the probability of a motor vehicle crash. Further, utility theory assumes independence of events, that is, a preference is independent of other possible outcomes. In complex systems such as transportation, this axiom of independence is violated – preference for driving may not be considered independently from preference to participate in one social event over another.

Transportation decisions involve a complex array of factors. Some investigators assert that typical judgment does not involve the consideration of all possible choices as

outlined in utility theory. Rather, individuals tend to rely on only three to five cues. In driving decisions these cues may be, for example, the weather, the traffic, or personal health. People have difficulty attending to two or more non-comparable aspects of a stimulus at the same time, and attention tends to shift from one cue to another and back again. Cues are thus dealt with in a linear, additive fashion and people often anchor their judgment on a single cue. Furthermore, individuals lack insight into their methods, and into the cues themselves. There are large individual differences between decision-makers, but over-confidence is a characteristic displayed by most in evaluating cues and making decisions (Hastie & Dawes, 2010). Cues with a strong relation to an event will be perceived by decision-makers as more useful, that is, they will have high *ecological validity*. The counterpart to the ecological validity of a cue is its utilization by the subject: cues may also be used more or less by a subject, known as *subjective utilization*. Mismatches between ecological validity and subjective utilization are one source of inaccurate judgments in that the individual fails to attach the correct weight to the cue (Arkes & Hammond, 1986). For example, because of high ecological validity a driver might anchor a decision to drive on a snowy day on having snow tires, ignoring cues related to personal health. Furthermore, the driver may under-utilize information about the condition of other people's tires, clearing of the roadways by municipalities, or even other snow-related cues such as windshield wipers and headlights. The individual may thus base a decision on only a few cues that seem most relevant to a perceived situation, and among these few cues, select only one or two for comparison.

Often, decision-makers' estimates of frequencies, probabilities, and outcomes are vague. People adjust their estimates from an *anchor* of information, or context. This anchoring effect introduces biases such as memory retrieval error and assigning excessive weights to what is already known (conservativism). Not only do we selectively remember our successes, we often have no knowledge of our failures and any knowledge we do have may serve to explain them away. The anchor used for estimates may also be biased by habits such as always starting with the same cue, most often the status quo. In fact, one of the most common human habits is to start with the most salient or important facts, then adjust in the direction that you think the truth lies (Hastie & Dawes, 1986).

When we need to make difficult decisions or judgments we tend to take the easier route and use automatic processes. Tversky & Kahneman (1986) suggest that heuristics are used to reduce complex tasks of assessing probabilities and predicting values. Although useful, heuristics can sometimes lead to severe systematic errors since they are based on limited data. These authors describe three main types of heuristics used in decision-making: 1) representativeness; 2) availability; and 3) adjustment and anchoring. Representativeness is the degree to which A resembles B. That is, if A resembles B then it is judged more probable that A originates from B. For example, people may judge the skill of a driver based on information that is irrelevant to driving, such as the model, year, and condition of the vehicle. Illusion of validity is another example of this type of heuristic. For instance, people have confidence in their "prediction" that an older woman of small stature, white hair, and glasses and a walker is more likely to be a non-driver than a driver. The availability heuristic refers to the ease with which information is brought to mind. Biases associated with this type of heuristic include the fact that cues that are more easily retrieved will appear more numerous and have higher saliency to the problem at hand. Ease in retrieving information and ease in imagining scenarios or outcomes interject further biases. The third type of heuristic, known as adjustment and anchoring, describes how people often start from an initial judgment and then adjust it to a final answer. Clearly, the bias is towards the initial judgment and depends on its accuracy. In using this heuristic there is a tendency to overestimate the probability of conjunctive events. For example, although they believe that a combination of ice on the road, bald tires, and fast driving is needed for a crash, they still judge it as more likely. People also tend to underestimate disjunctive events. For example, certain individuals may ignore their decreased ability to parallel park as a sign of their decreased driving skills.

Finally, decisions about transportation have frequently been described as habitual, or at least as routine. The distinction between habitual and routine has been described as a continuum from less to more habitual with the ultimate goal of habit to reduce the mental workload associated with decision-making (Garling & Garvill, 1993). For the majority of adults, driving represents the status quo for meeting transportation needs. However, as in many decisions, factors within the decision context are subject to change, such that when a threshold of alterations is reached, individuals consider alternative choices and possibly abandon the status quo (Hollmann, Jarvis & Bittner, 2015). Garling et al. (1998) propose

that the decision process sometimes has two phases, where the first is a decision to replace the status quo, and the second is a choice of alternative replacements. A stimulus is needed to provoke a decision to replace the status quo, and involves comparisons between alternatives and the status quo; the resulting deliberation may be more or less extensive, and sometimes may be considered as passive decision-making, where active assessment is not engaged.

2.1.2. Ecological Models

The Ecological Model of Aging proposed by Lawton and Nahemow (1973) is the dominant and most frequently used model in the family of Person-Environment fit (P-E) frameworks. It arose from Lewin's (1935) proposition that an individual interacts with a "lifespace" which includes not only the person and the physical space of the interacting environment, but also the "psychological space" in which the P-E interaction takes place. The nature of the individual's response to the environment depends on level of competence, which is defined as, "the theoretical upper limit of capacity of the individual for functioning in the areas of biological health, sensation, perception, motor behaviour and cognition." Behaviour is not only a function of the person and the environment, but also an interaction between the two components. The model graphs increasing environmental pressure against increasing level of competence (Lawton & Nahemow, 1973; Lawton, 1980) (Figure 1). The equation B = f(P,E, P*E) is illustrated as a line representing optimal balance between press and competence. Zones above and below the line represent a reasonable balance between press and competence where the individual can demonstrate successful behaviour. The model also shows zones of positive affect (successful behaviour) and zones of negative affect (maladaptive behaviour) resulting from the interacting dimensions of competence and environmental press. The zones of

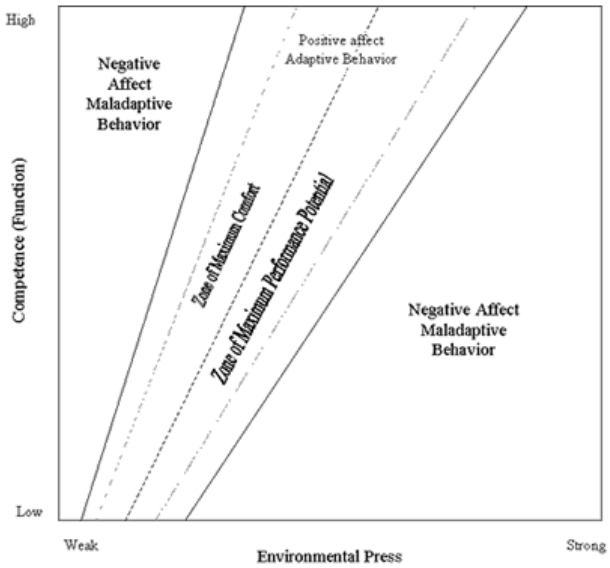

Figure 1. Lawton's (1980) Ecological Model

“positive affect” increase in size as the P-E interaction moves from low to high levels of competence, forming an adaptation zone shaped like a cone. However, beyond these zones the press is either too high or too low for the abilities of the individual and maladaptive behaviour occurs. For example, if driving demands are too complex (e.g., ice and snow) or too weak (e.g., long boring road), driving errors and crashes will occur.

P-E fit provides a good descriptive model of the driving task with respect to successful driving versus negative outcomes such as driving errors, near misses, and crashes. It helps us to understand how aging, when accompanied by physical and/or cognitive declines, affect the ability to drive. It also highlights the fact that as frailty increases, there is less ability to adapt to the demands of the driving environment. It is important to note that as the competence of the individual decreases, the zone of successful behaviour narrows. This is especially relevant to aging and driving. As increased frailty develops with advanced age the individual is able to cope within a narrower band of driving environment complexity. Whereas younger drivers can successfully deal with high speeds, poor weather, and complicated intersections, age-related declines in vision, reaction time and cognitive processing speeds reduce the manageable environment to, for example, a combination of slower speeds, good weather, and simple roadway geometry. For older drivers with decreased competence, too high demand of the driving environment represents the most important factor in driving safety.

P-E models present a rational risk assessment approach, but do not include a significant consideration of factors such as attitudes and motivations to drive. Even though an individual may struggle to meet the demands of the driving environment, attitudes about driving and the desire to drive may over-ride the rational evaluation of an ability-demand balance. Classen, Winter and Lopez (2009) found that older adults’ driving is innately connected to their identities and desire to maintain independence, resulting in resistance to modify or cease driving, or even denial of P-E imbalances. Jouk, Sukhawathanakul, Tuokko and colleagues (2016) also demonstrated the impacts of pro and con attitudes about self and others on driving decisions. Furthermore, P-E fit models devote little attention to coping with perceived imbalances, that is, they do not specify the criteria by which the person will choose from among various methods for resolving P-E misfit. For example, the model indicates that subjective P-E imbalances may be tolerated by reducing

the importance of the dimension on which misfit occurs, such as reducing the importance of travelling to a destination. However, the model does not articulate the conditions under which this method of adaptation will be used, or when this adaptation is applied in relation to other forms of adaptation. In other words, P-E models provide guidance on what might trigger driving decisions, but not specifically on how these decisions are made.

P-E models are offered as a basis for understanding adaptations to aging. However, they fall short in not describing how the adaptation actually occurs. P-E models appear to presume that the aging individual makes decisions about their behaviour in order to reduce the likelihood of negative outcomes, they do not include this. This thesis attempts to go beyond what is described in P-E models to better understand how older drivers adapt to their declining resources through the decisions they make. Decision models are therefore included in this thesis, in combination with P-E models, in an attempt to describe aging adaptations more fully.

2.1.3. Summary

Together, these two major theoretical frameworks were used to guide this research. The research addresses questions about habitual and conscious decision-making for driving, and the processes used by the individual in making these decisions. Behavioural Decision Theory describes how individuals reduce their mental workload through habitual behaviour, how triggers motivate challenges to the status quo, and how individuals use various cues and processes to make conscious decisions about driving. Ecological models describe imbalances in the person-environment equilibrium that accompanies aging as the underlying reasons for a need to change behaviour; the individual's awareness of these imbalances provides the trigger for the conscious decision-making.

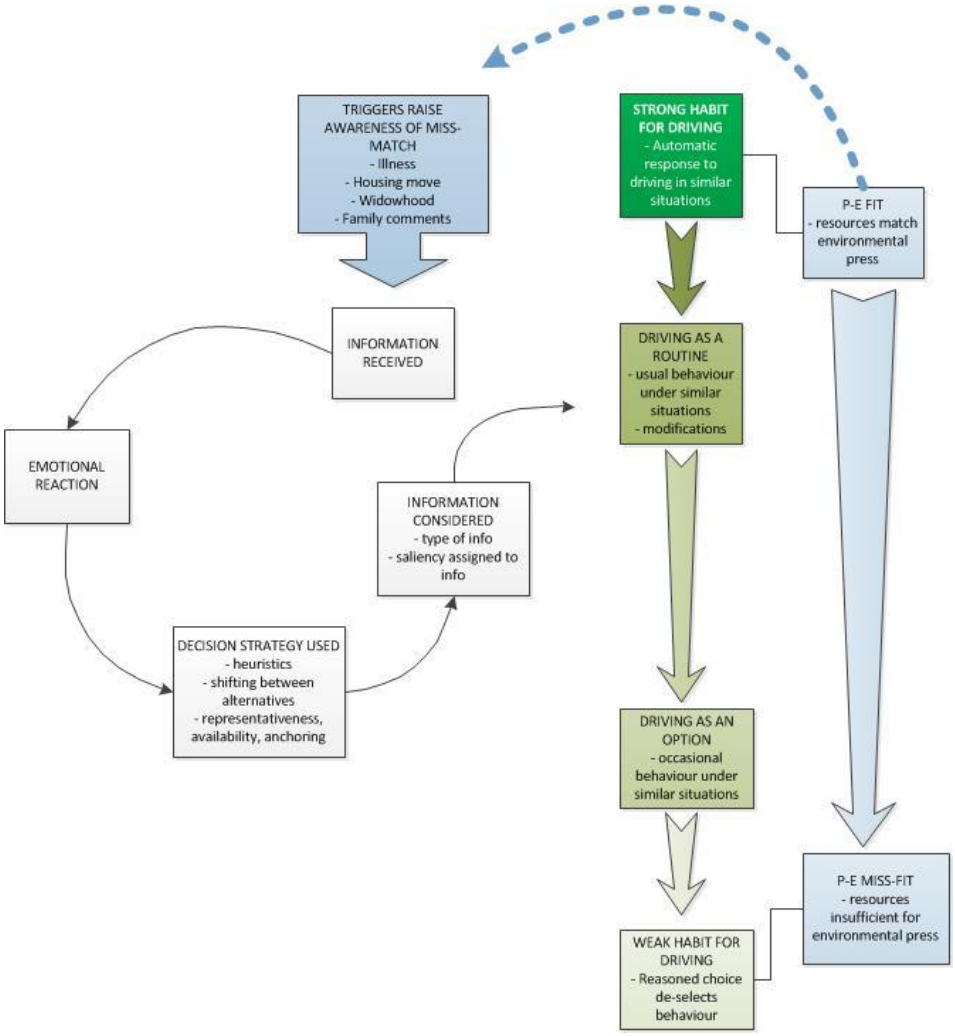

Figure 2. Conceptual illustration of model relationships

Figure 2 presents an illustration of possible relationships between Decision Theory, P-E Fit models, and habit that were used to frame this research. The top right of the diagram shows that when the individual has sufficient resources to cope with the demands of the driving environment, driving behaviour can be strongly habitual both in choice of transportation mode and in driving style. The arrow on the right side of the illustration represents a decrease in the P-E balance as a result of aging, presumably through age-related declines in personal resources. As the P-E fit declines, the habit strength for driving is also shown to weaken as illustrated by the series of arrows to the left. The weakening of habit may not occur precisely in sync with the decline in resources, but it is suggested that when the P-E fit is sufficiently eroded the habit strength for driving

will be weak. The left side of the diagram illustrates how the decision process of the individual influences the habit strength for driving. It is presumed that changes in the P-E fit will be noticed through triggers that alert the individual. These triggers may be related to personal, social, or environmental factors such as illness, comments from family, or a change of residence that alters the driving environment. A dotted line is used to illustrate this link because P-E imbalances are not always immediately evident. The individual receives some information related to their ability to meet the demands of driving and, if acknowledged, invokes a decision strategy. This decision interrupts the habitual driving behaviour with the result that the amount and style of driving is altered. This process may occur along the movement from strong to weak driving habit as the individual progressively self-restricts driving. Habit strength weakens, and eventually decisions are made frequently to de-select driving as a mode of transportation.

Chapter 3. LITERATURE REVIEW

Road safety experts have been challenged to predict, among the population of older drivers, which individuals are at higher risk of crash involvement. The research has taken mainly a driver-centric approach, focusing on age-related declines that threaten the ability of the elder to manage the demands of the driving task. A similar approach has been applied to young driver risk, with a strong focus on identifying the specific individual components which contribute to the increased risk experienced by all young drivers. For example, much research has focussed on driver skills such as perception and crash risk: hazard perception for young drivers (Boufous, Ivers, Senserrick et al., 2010) and useful field of view for older drivers (Rusch, Schall, Lee et al., 2016). This type of research has helped to identify the characteristics and behaviours contributing to driver risk, informing countermeasures such as restricting night-time driving. However, what is missing in this approach is the understanding of the relationships between various factors that contribute to crash risk. The focus has been on 'fixing' the driver through education or training, or through 'excluding' the driver through sanctions or restrictions. Meanwhile, the complex interaction of factors that influence driving behaviour are largely unexplored.

An alternative 'systems approach' to driver safety has evolved over the past few decades. The systems approach recognizes the role of the overall transport system in crashes. It is characterized by a top-down approach that recognizes safety as a system property rather than the sum of components and actions. The systems approach integrates technical, organizational, and social aspects. Further, the systems approach provides ways to model, analyze, and design specific safety structures rather than trying to specify general principles that apply to all organizations (Scott-Parker, Goode & Salmon, 2015). The systems approach allows for questions such as: how might the behaviour of family and friends influence driving behaviour; how do vehicle and road design, together, contribute to crash risk; and how do advertizing and high insurance costs interact to influence driver decisions (Scott-Parker, Goode & Salmon, 2015).

The focus of this research fits within a systems approach to road safety in exploring driving as an interaction between many elements concerned with the driver, the technical aspects of driving, the organization of roadways, and the social context within

which drivers make decisions. That is, this research considers not just the failing resources of the aging individual in predicting risk such as in driver-centric studies that try to predict risk associated with, for example, reduced cognitive processing speed. Instead, it addresses how the individual integrates information from various components of the transport system that ultimately determines the driver's risk. In other words, this research approaches questions of road safety from the perspective that driving risk for older adults is determined by how they integrate various components in ultimately making a choice of whether to be exposed to risk or not.

Since this research adopts a systems approach rather than a driver-centric approach, this review of the literature emphasizes our knowledge on driving behaviours believed to be related to age-related changes. Accordingly, it presents a summary of recent findings on driving self-regulation which may be thought of as the outcome of interactions between factors, across the transport system, that influence the behaviour of the elder. Although age-related declines sometimes influence driving decisions, these declines *per se* do not generally cause changes in driving patterns. Rather, it is the individual's beliefs about their driving abilities that are the major predictors of behaviour change (Blanchard & Myers, 2010). Therefore, only a brief overview of some of the age-related declines facing aging drivers is presented to support the reader's understanding of the relevance of P-E fit models to aging and driving. This literature review also presents findings on decision-making in relation to how older adults integrate technical components of driving and social factors that form the context within which decisions are made.

3.1. Personal Resources, Environment, and Driving

Safe driving requires that the individual has adequate resources to meet the demands of the driving environment. In the literature on elder drivers, Person-Environment fit theories have been used primarily to describe how the aging process reduces the resources of the individual to the point where the demands of the environment exceed their resources, resulting in negative outcomes. However, the balance is not unidirectional. P-E fit can also be used to explain how increases in environmental factors such as roadway complexity, traffic density, and vehicle features, even in the absence of a decrease in personal resources, can upset the P-E balance. Such changes in

environmental factors may occur, for example, as neighbourhoods grow and develop, as the result of a change in residence, or from the purchase of a new vehicle. Aging individuals may therefore be faced with various pathways through which the P-E balance is upset: through decreases in personal resources, through increases in environmental demands, and through a combination of both. A review of the literature reveals ample discussion on how reduced personal resources of the aging individual results in negative driving outcomes. Less is documented about how increasing environmental pressure affects the driving of elders.

Physiologic changes that occur with aging include changes in vision, strength, flexibility, and reaction time. These changes contribute to difficulties for elders – difficulties that are acknowledged by some elders but not by others. Benekohal et al. (1992) surveyed 664 senior drivers about their driving challenges. Reading street signs, negotiating intersections, finding the appropriate lane, following pavement markings, and responding to traffic signals were the main problems cited by older drivers. They also experienced difficulty judging distances and gap. Most of these problems are related to visual and visual processing changes, and to cognitive executive declines.

The impact of aging on driving is a complex interaction that is not easily predicted. The individual may be able to compensate for personal losses under some circumstances but not others, with the result that changes in either the person, the environment, or both has a personal rather than a systematic effect. For example, although visual acuity in itself is not well correlated with crashes, other visual problems such as low contrast sensitivity associated with cataracts significantly increases crash risk (Owsley, Stalvey, Wells et al., 2001). However, how individuals cope with their visual changes in terms of driving restrictions, varies. For instance, Owsley, McGwin & Searsey (2012) found that although more than half of the individuals in their study had cataracts, the prevalence was very low amongst those over age 80, mainly due to surgical correction of the condition.

3.1.1. Vision and Visual Processing Changes

Driving is largely a visual task, comprised of visual acuity and visual processing. In general, the visual performance of drivers begins to progressively decline after the age

of about 45. Visual acuity deficits are common. Among adults age 65-74, slightly more than half have age related macular degeneration, and this increases to 84% of adults age 85 years and older. In addition, 37% of men and 40% of women age 65 years and older have a secondary diagnosis, especially cataracts (57%), and glaucoma (13%) (Elliott et al., 1997). Visual defects that may affect driving include reduced static and dynamic visual acuity, reduced visual field including blind spots, reduced contrast sensitivity, slowed accommodation reflexes (shifting from near to far vision), increased glare sensitivity and recovery from glare, and reduced visual field sensitivity (peripheral vision). Increased sensitivity to glare does not affect daytime driving but makes night driving more challenging, makes it more difficult to read road signs, and harder to determine the colour of traffic signals. Slower lens accommodation results in delays refocusing between the dashboard and the roadway ahead. Latency time to initiation of eye movement toward a location increases with age, and the speed of eye movement declines, so that visual search for targets is delayed (Kaneko et al, 2004). Results of glare sensitivity and glare recovery studies have shown correlations with on-road crashes (Theeuwes, Alferdinck & Perel, 2002). Low performance on tests of contrast sensitivity has been highly correlated with driving performance (Wood & Carberry, 2006) as well as self-reported difficulties in both daytime and night driving (Blanchard & Myers, 2010; Wood, Chaparo & Carberry, 2010). In a study of Indian drivers, the contribution of individual visual defects on number of cashes was depth perception, nasal vision, colour blindness, vertical vision, acuity, glare recovery, binocular vision, contrast sensitivity, and peripheral vision (Verma, Chakrabarty, Velmurugan et al., 2015).

In addition to visual acuity problems, reductions in visual processing decrease the ability of the individual to meet the demands of the driving environment. Visual processing is the sequence of steps that information takes in its passage from the retina to the visual cortex of the brain where the image is interpreted into meaning. Decreases in visual processing speed have been found in 40% of drivers over age 70 years (Owsley, McGwin & Searcy, 2012). In an environment that is constantly changing, such as in driving, the ability process visual information in-the-moment is often critical. For example, quickly and accurately judging vehicle speed is critical for determining when it is safe to pull out from a driveway in front of an oncoming vehicle. This requires quick evaluation of relative rates of visual expansion (looming) of the approaching vehicle. Older adults are over-

represented in right-of-way intersection collisions, (Clarke, Ward, Bartle & Truman, 2010) and slowed processing is believed to be a major contributor. Older adults' visual processing of looming has been studied by Poulter and Wann (2013) and found to be slower and less accurate than that of younger drivers. In fact, these authors concluded that for each decade of age, the ability to determine the speed of an oncoming vehicle decreases 2.8 mph for larger cars and trucks, and 3.4 mph for smaller vehicles and motorcycles. Drivers in the study who were over age 75 were unable to distinguish between a vehicle approaching at 20 mph versus 40 mph. Furthermore, the older adults in the study were unaware of their deficit.

Attention enhances the processing of selected visual information. A fundamental capacity of visual attention is that it can be concurrently allocated to multiple objects, that is, divided between different locations, objects or features (Hogendoorn, Carlson, VanRullen & Verstraten, 2010). Divided attention, which decreases as people age, has received particular interest as a predictor of driving performance in older drivers. During driving, individuals are required to shift attention between various stimuli while successfully completing more than one action at a time. Declines in divided attention reduce the individual's ability to scan the environment for hazards, such as pedestrians at intersections, and execute appropriate maneuvers.

Two stages of attention have been defined. The first stage, *monitoring*, is the anticipatory allocation of attention to a specific region of the visual field. The second stage, *access*, involves the specific allocation of resources to one or more visual stimuli such that their properties become available to the consciousness (Hogendoorn et al., 2010). Older individuals demonstrate poorer visual search skills by allocating a larger percentage of their visual scanning time to a small area, and by revisiting the same areas during their visual searches, indicating decrements in processing visual information (Dukic & Broberg, 2012). As the road environment becomes more cluttered with signage, traffic, pedestrians, and signals, older drivers take longer to search out, recognize, and respond to targets (Ho, Scialfa, Caird, and Graw, 2001).

Adequately performing the first, *monitoring* phase of visual processing is critical to detecting all of the relevant information needed to make safe driving decisions. The useful

field of view (UFOV) is the “attentional window” of drivers over which they can adequately divide their attention between central and peripheral tasks. There is clear evidence of reduction in sensitivity across the visual field being associated with crash involvement among older drivers (Ball and Owsley, 1993; Owsley & McGwinn, 2010; Classen, Wang, Crizzle et al., 2013). Richardson and Marottoli (2003) showed that declines in visual attention had a significant effect on 25 driving items including scanning the environment, interaction with traffic and pedestrians, yielding right of way, responding to other vehicles, proper lane selection, steering recovery, making intersection turns, monitoring speed, and judging distances. Ability to perceive and respond to multiple targets in a wide visual area has been shown to be some of the variables most strongly predictive of crashes amongst older adults. Studies have demonstrated that older drivers with 40% or more reduction in UFOV were 2.2 times more likely to have a crash compared with controls (Owsley et al., 1998).

Although visual acuity changes occur with aging, many can be mitigated with corrective lenses or surgery and, with certain exceptions, have little impact on driving. However, changes in visual processing have significant impacts on crash risk, with the added problem of being less noticeable by the drivers themselves.

3.1.2. Physical Changes

Aging is often associated with an accumulation of chronic diseases, such as arthritis and osteoporosis, which affect body positioning and physical movement in a vehicle. A substantial proportion of those aged 65 years or more have arthritis (42%), heart disease (16%), diabetes (10%), cataracts (15%), glaucoma (5%), or effects of stroke (4%) (Millar, 1999). However, the association between disease *per se* and crashes among older drivers is not clear (Marshall & Man-Son-Hing, 2011), and many health conditions are not associated with older drivers voluntarily giving up their car keys (MacLeod, Satariano & Ragland, 2014). Research studies have shown mixed results between crash risk and specific diseases. This may be because diseases manifest themselves slightly differently in different individuals, because individuals have varying degrees of disease severity, because individuals cope and compensate differently, or because multiple conditions occur in various combinations that affect the elder in different ways. Additionally,

differences in the driving environment put varying demands on the driver which may differentially affect the P-E balance and fitness to drive. Furthermore, most diseases are treated with medications, however, individuals react differently to the use of medications. In fact, Rosenbloom and Santos (2014) as well as Monárrez-Espino, Moller, Berg et al (2013) have acknowledged that it is difficult to separate the effects of the basic medical problems from the effects of the medications used to treat those problems. A review of the scientific literature on the effects of medical conditions on driving (Dobbs, 2005) also noted the impacts associated with acute, chronic or a combination of illnesses differ.

The impact of age-related physical changes to driving has been documented by the American Medical Association's Older Driver Program. The *Physician's Guide to Assessing & Counseling Older Drivers* was published in 2003 and updated in 2010 (Carr, Schwartzberg, Manning & Sempek, 2010) to aid physicians in understanding the possible driving limitations of their patients. Likewise, the Canadian Medical Association's *Driver's Guide: Determining Medical Fitness to Operate Motor Vehicles, 8th edition* (CMA, 2013), outlines possible impacts of illnesses, injuries, surgeries and other conditions on all drivers. However, functional disability due to medical conditions such as arthritis and illness can be episodic (Colon-Emeric, Whitson, Pavon & Hoenig, 2013) and therefore have variable impact on overall driving. Some older drivers report they have difficulties with physical movements in driving such as inability to turn the neck to perform adequate visual checks, or difficulties getting into and out of a vehicle (Herriotts, 2005; Cranney et al., 2005), but these do not necessarily result in decisions not to drive. Falls, for older adults, are associated with physical declines, mediated by visual and cognitive changes (Reed-Jones, Solis, Lawson et al., 2013), and are often used as an indicator of reduced physical health and function. Several studies have documented falls as a predictor of adverse driving events in older adults, and one study reported that the odds of crash involvement were 50% higher for older drivers reporting a history of falling in the previous year (Huisingh, McGwin, Orman & Owsley, 2013). However, involvement in a fall is not considered sufficient reason to stop driving.

The Canadian Medical Association acknowledges in their *Driver's Guide* that illness diagnoses (Canadian Medical Association, 2013 p7), in themselves, are not adequate evidence of decreased driving ability:

> *"Recent court decisions have recognized that a driver's ability to accommodate and function with a given medical condition varies with the individual. These court decisions have also established the right of individuals to be assess individually for their ability to drive safely."*

In essence, although some physical changes may affect driving, many can be compensated for, albeit with varying degrees of success.

3.1.3. Cognitive Changes

Attention, processing speed, memory and executive function, visuo-spacial processing, and global cognitive function have each been associated with driving outcomes among older adults (Stinchcombe, Odenheimer & Bédard, 2015). The impacts on driving of deficits in many of these domains has been studied extensively. However, the current study does not address the impacts of cognitive changes on driving so a full discussion of these factors are beyond the scope of this review. However, the contribution of habit to driving is within the scope of this study, and since driving is a highly automated task, a brief discussion of how individuals with mild cognitive changes may continue to drive is presented.

A threshold level of cognitive ability is needed to safely pilot a vehicle within a traffic environment. This is clearly demonstrated in patients with diseases that affect the brain such as Alzheimer's Disease, Parkinson's and Huntington's (Aksan, Anderson, Dawson et al., 2015; Devos, Nieuwboer, Vandenberghe et al., 2014). However, in the early stages of diseases such as these, individuals have demonstrated an ability to perform, primarily because much of driving is an over-learned, automatized process. In a study of over 6,000 older drivers, 61% of older men with moderate cognitive decline (MMSE < 20) were still driving (Shimada, Tsutsumimoto, Lee et al., 2016). Researchers now accept the model that intelligence is the product of two distinct types of skills, known as fluid intelligence and crystallized intelligence, each of which decline at different rates over the life span. Fluid intelligence refers to the capacity to process novel information where little or no prior knowledge is held. Crystallized intelligence, on the other hand, is based on the accumulation of information, skills, and strategies throughout life (Schaie, 1996). As

people age, declines in areas associated with fluid intelligence may occur with little or no decline in crystallized intelligence, and in fact, increases in crystallized intelligence may even be noted. Since crystallized intelligence increases with repeated experience and practise, it becomes less susceptible to degradation. Reliance on this crystallized intelligence, associated with automatic movements such as steering and braking, allows some older drivers to continue their ability to manoeuver a vehicle under predictable conditions, although not under unfamiliar or emergency situations (Stinchcombe & Gagnon, 2013; Yang & Coughlin, 2014).

The brain undergoes many changes throughout the life span. Beginning about age 50, neurons in the hippocampus of the brain are lost at a rate of about two percent per year. This area of the brain is involved in short-term memory, with the result that older people have greater difficulty storing and retrieving material (Quadagno, 2002) such as street names, positions of pedestrians, and locations of surrounding vehicles. Visual spatial processing also occurs in the hippocampus and therefore suffers age-related declines. Within the driving environment, short-term memory declines are relevant to tasks such as safe lane changes and way-finding, and visual spatial declines are particularly relevant to tasks such as lane adherence and parking.

Declines in prefrontal cortex activity that occur with aging affect the ability to divide attention between tasks. Several studies have found that during a complex attention-demanding memory task, activity in the inferior left prefrontal cortex areas is reduced in older adults. Anderson et al. (2000) found that when subjects were required to divide their attention between a memory task and an auditory-motor response task, older adult performance was significantly reduced for memory encoding.

The frontal lobes of the brain control executive functions, processes that activate, integrate, and manage other brain functions. Beginning from age 45, substantial age-related changes can be seen, and these areas of the brain are most vulnerable to diseases such as Alzheimer's. Results of the early declines in dorsolateral regions of the frontal lobes can be seen in older driver's changes in tasks that require planning, paying attention, and responding, for example way-finding, proper lane selection, responding to traffic signals, and brake reaction time (Richardson and Marattoli, 2003), although such

behavioural changes are not likely to be manifested before about age 70 despite the physiological changes (Garden et al., 2001).

There is a vast literature on the effects of cognitive impairment on driving. In general, it has been found that elders with mild cognitive impairment do not always have an increased risk of crash (Kawano, Iwamoto, Ebe et al., 2016) whereas later stages of dementia is associated with increased crashes as well as driving cessation (Meuleners, Ng, Chow & Stevenson, 2016; Dit Asse et al., 2016). Aksan et al (2015) found that for on-road driving tests, older adults with Alzheimer's Disease and Parkinson's Disease performed worse. Further, they found that different domains of cognitive functioning predicted distinct facets of driver safety on the road. Memory and set-shifting difficulties predicted performance in navigation-related secondary tasks, speed of processing deficits predicted on-task safety errors, and visuospatial construction problems predicted baseline safety errors.

The impact of decreased cognition in driving, therefore, may be seen as occurring along a continuum wherein thresholds of performance decrements may occur. However, Piersma, de Waard, Davidse et al (2016) warn that the etiology of dementia could contribute to different effects on driving, but these differences have not yet been defined.

3.1.4. Dealing with P-E Imbalances

It is well documented that older drivers compensate for their declining resources, at least those drivers who are cognizant of their changes will frequently, although not always, adapt their driving habits. Older drivers have reported that they generally drive slower to compensate for slower reaction time, and the fact that they receive fewer speeding tickets supports this claim. They have reported that they leave additional space between themselves and the vehicle in front of them for the same reason, although observation studies and their higher involvement in multiple vehicle crashes suggest this adaptive strategy is not always practiced. Older drivers have also reported that they avoid making left turns, driving in bad weather, and driving at night to compensate for their difficulty judging distance, making quick decisions, and reduced contrast vision. However, they continue to be over-represented in intersection crashes suggesting they do not

always accurately evaluate their own abilities in making decisions about how much time they have to manoeuver their vehicle safely (Hassan, King & Watt, 2015). In addition, older drivers have reported relying on other support systems to continue driving, such as using a co-pilot (usually a spouse or friend) to help them read road signs, interpret the colour of traffic lights, spot hazards, and plan a route. Other support systems have included vehicle modifications such as extra or wider-angle mirrors to compensate for inability to turn the head, hand controls to compensate for weak lower limbs or neuropathies, and cruise control to reduce fatigue.

In acknowledging the importance of being able to continue driving to an old age, researchers have considered several additional approaches to support older drivers. Mature driver education programs (e.g., 55 Alive) have been available for several decades to help older drivers stay knowledgeable about their skills, but such programs have not proven very effective as a stand-alone approach (Korner-Betinsky et al., 2009). Graduated de-licensing has been proposed to allow elders to continue driving longer, albeit in a reduced environment, and has demonstrated some reduction in crash risk (Nasvadi and Wister, 2009). Programs for cognitive training such as DriveSharp have been developed over the past few years and claim to be based on the science of neuroplasticity—the ability of the brain to change itself chemically, physically and functionally at any age. These cognitive training programs purport to reduce the crash risk of older drivers by 51% (Ball, Edwards, McGwin, and Roenker, 2009) however these results have not been replicated.

The development of vehicle technologies offers, to the aging driver, another method of dealing with declining resources. Vehicle technologies are evolving that attempt to reduce the demands of the driving environment so that they are better matched to the resources of the driver. Crash-avoidance technologies, especially, are designed with the goal of reducing the skills needed to detect and respond to hazards. Considering the declining resources associated with aging and illness, these technologies promise to tip the balance more favourably for the driver by controlling the demands of the vehicle and roadway environments.

New vehicle technologies are being developed with two primary goals in mind: to increase the safety of driving, and to increase the comfort of the driver. Perel (1998)

identifies two classifications of vehicle technologies that address the declining resources of aging drivers. Collision avoidance systems aim to compensate for reduced visual abilities and visual processing, and slowed reaction times. Traffic information systems address short-term memory deficits, visual problems, and executive function declines. He notes that there are two key issues in whether or not in-vehicle technologies will successfully address these problems: 1) the extent that the devices address the specific safety and mobility needs of seniors; and 2) whether they are designed to minimize distraction and be easily understood and operated according to human factors design.

Although vehicle technologies seem promising, Amditis et al. (2010) warn that the driver is not always capable of receiving and understanding the messages that are given by the different technology systems. Major reasons are the driver's physiological state (e.g., fatigue), experience with the technology, and cognitive overload associated with "disparate" information flow. Also, the complex traffic environment such as traffic volume, multiple lanes, pedestrians and cyclists, and external non-traffic related issues such as billboard ads also affect the driver's ability to receive and understand system warnings.

3.2. Self-Regulation

In many developed countries, the proportion of older drivers is rapidly rising and the data reveal that lifelong drivers – at least in the current cohort – are travelling greater distances later into their lives (Federal Highway Administration, 2015). Self-regulation has been proposed as a way to preserve the independence of older drivers while maintaining safety (Berry, 2011; Charlton, Oxley, Fildes et al., 2006), however, evidence is mixed on the success of this strategy for all drivers. Self-regulation is essentially a process of making choices about when, where, and how to drive. Its relevance to this research project is noted.

Gwyther and Holland (2012) define self-regulation as, "a mechanism for safely extending driving mobility and independence in an ageing population." Traditionally, self-regulation has been thought of as driving avoidance in response to age-related functional declines (Baldock, Mathias, McLean & Berndt, 2006; Ball, Owsley, Stalvey et al., 1998), and other definitions have reflected this operational approach. For example, D'Ambrosio,

Donforino, Coughlin and colleagues (2008) define self-regulation as “the process of adjusting driving patterns by driving less or intentionally avoiding driving situations considered to be challenging”. Wong, Smith and Sullivan (2015) define self-regulation as, “voluntarily restricting one’s driving to avoid situations that one considers unsafe”. However, self-regulation may be considered to include other strategies such as pre-trip planning, slower speed of travel, vehicle adaptations, using a ‘co-pilot’, and turning off the car radio, and it has been suggested that the definition be expanded even further to include types of vehicles purchased, vehicle design features chosen, and where elders choose to live (Molnar, Eby, Langford et al., 2013). Further, Gwyther and Holland (2015) incorporate intrinsic motivation into their definition of self-regulation as, “a strategy used by drivers to improve feelings of safety and wellbeing.”

Studies on the prevalence of self-regulation have had mixed results, due in part to different definitions of self-regulation applied in the studies as well as different study populations and different methods of data collection. As an illustration, study participants are often asked about avoidance of night-time driving. Reported results vary substantially, ranging from 8% (Baldock, Mathias, McLean & Berndt, 2006) to 25% (Charlton et al., 2006), to 80% (Ball et al., 1998). These differences may be due to the different ways in which the question are asked, for instance, “Do you ever avoid night-time driving?”, “Do you always avoid night-time driving?”, or “Do you avoid driving when it is dark?” which may be interpreted slightly differently. The gender distribution of the study sample may also be contributing to the different findings since women are more likely to say they drive less and/or avoid more driving situations in which they feel uncomfortable (Charlton et al., 2001; Gwyther & Holland, 2011; Siren & Meng, 2013). Age also has a significant effect. Numerous studies have demonstrated that self-reports of driving avoidance increase with age (Naumann, Dellinger & Kresnow, 2011; Charlton, Oxley & Fildes, 2006; Carmel, Rechavi & Ben-Moshe, 2014). However, the impact of age may be largely associated with increasing health conditions so that the age of participants in the sample, in itself, may have differing effects. The impact of health status is also variable in regards to self-regulation. Individuals with visual problems, for example, have repeatedly been found to reduce the amount of driving they do (Ackerman, Vance & Ball, 2016; Sandlin, McGwin & Owsley, 2016; Meng & Siren, 2015; Davis, Conlon, Ownsworth & Morrissey, 2016). However, those with cognitive problems are sometimes but not always found to increase

self-regulation, depending on the individual's awareness of the cognitive deficits (Devlin & McGillivray, 2016; Wong, Smith & Sullivan, 2012). On the other hand, it has been found that other health problems may have minimal impact: some studies have found that the presence of heart problems (Ackerman, Vance & Ball, 2016) or a history of stroke (Dit Asse et al., 2014) did not affect self-regulation. Furthermore, whereas earlier studies tended to survey elders only about common situations they avoided, more recent studies have included a wider range of behaviours (e.g., Molnar, Eby, Langford et al., 2013; Festa, Ott, Manning et al., 2012) and have included comparisons with younger populations who are also reported to self-regulate according to these definitions (Naumann, Dellinger & Kresnow, 2011; Gwyther & Holland, 2012).

By far the majority of studies on self-regulation rely on self-reports of driving distances and driving behaviours. Self-reports are often criticized as being inaccurate, in part due to problems with travel recall (Wolf, Oliveira & Thompson, 2003) but also with social desirability bias (Naher & Krumpal, 2012). The emergence of in-vehicle technology has helped to clarify this question. Blanchard, Myers and Porter (2010) compared self-estimates, trip diaries, and data collected from instrumented vehicles in a group of older drivers and confirmed inaccuracies of self-reports. Driving diaries were incomplete (trips missed) and inaccurate for the number of stops made during the trips. Estimates of distances travelled, collected by interview at the end of the study, were also found to under- or over-estimate actual travel. Also, less than half of the participants who said they usually drive on freeways or highways actually did, although the one-week study period may have been too short to adequately capture this behaviour. Agreement with self-reported self-regulation occurred only with driving at night, driving at night in bad weather, and driving on 3-lane highways over 100 kph. Despite self-reports of avoidance, everyone in the study made left turns and 85% drove during rush hour at least once during the study. These results support others who have found self-report measures of driving exposure to be inaccurate, although interpretation of travel behaviours recorded electronically may be difficult and therefore not always reliable (Molnar, Charlton, Eby et al., 2013). Other studies comparing travel diary and self-reports of walking, with objective data, show similar biases and inaccuracies for individuals. However, when examined at an aggregate level, Kelly, Doherty, Mizrak, Marshall et al., (2014) assert that self-reports are considered to have high validity and are needed to interpret the objective data.

The main assumption of many studies, in keeping with Person-Environment fit, seems to be that self-regulation occurs in older populations in response to functional declines (Festa, Ott, Manning et al., 2012). It is supposed that as health problems arise, individuals adjust their overall driving patterns proportionately. Some studies do report a correlation between health and self-regulation behaviours, but the results are inconsistent. For example, Molnar, Eby, Langford et al (2013) recruited older adults from the community and from geriatric clinics specializing in vision, cognition, and psychomotor functioning. Individuals recruited from the clinic rated their health as poorer and reported significantly more avoidance behaviours for some situations, specifically driving at night, in unfamiliar areas, on expressways, and talking with passengers. However, there was no self-regulation of other behaviours such as driving in bad weather, in traffic, or making left turns. Further, the clinic population did not report higher levels of other strategies such as advanced trip planning, using a co-pilot, increasing following distance or avoiding distracting behaviours such as eating or reading a road map. Self-regulation, therefore, is likely not a behaviour applied universally to all driving tasks as health declines. Rather, self-regulation appears to be driven by conscious decision making, and is influenced by other factors or decision contexts.

Ability to accurately self-evaluate the impacts of health on driving, especially cognitive problems, is also considered an important factor in self-regulation. Drivers with mild cognitive impairment have been found to overestimate their driving abilities resulting in inappropriate self-regulation (Okonkwo, Griffith, Vance et al., 2009). Over a 5-year period it was found that older drivers with reduced Useful Field of View performance at baseline limited their driving exposure faster than those categorized as not at risk. However, their crash rate was higher, suggesting they did not adequately assess their health status in relation to their abilities (Ross, Clay, Edwards et al., 2009). In a study of the relationship between cognitive impairment and self-regulation, Kowalski, Love, Tuokko and colleagues (2012) found no effect of cognitive status on whether drivers restricted or reduced their driving or whether they were seriously planning to restrict or quit driving within 6 months. However, those with higher levels of cognitive impairment were less likely to be current drivers, that is, more likely to have already have stopped driving. This suggests that a subset of elders with cognitive problems are aware of their difficulties but another subset are unaware, or else ignore their difficulties in order to continue driving.

There is some support for the explanation that some drivers with cognitive challenges lack insight. In a longitudinal study of active drivers diagnosed with Alzheimer's disease, caregivers reported that those who failed to voluntarily restrict their driving were unaware of their deficit (Cotrell & Wild, 1999). Furthermore, increasing awareness by providing feedback on poor cognitive performance tests has resulted in increased reported avoidance behaviours over a 3-month follow-up (Ackerman, Crowe, Vance et al., 2010).

On the other hand, Seniors-on-the-MOVE is an educational program designed by community safety leaders in Maryland that focuses specifically on self-regulation of driving (Stalvey & Owsley, 2003). The program is delivered as four 2-hour classroom sessions. Jones and colleagues (2011) used a randomized crossover design to pilot test and evaluate the program on a small sample (N=58) of older drivers (mean age 74). They found the program had no effect on self-reported driving behaviours including driving exposure in low-risk and high-risk environments, distance, or time of day. However, self-selection bias may have contributed to the null impacts since some of the participants indicated attending with the purpose of continuing their driving. Furthermore, participants in the study reported already self-restricted driving behaviours at baseline, including low mileage, limited time-of-day travel, and driving mainly on local roads.

Self-regulation has traditionally been conceptualized as a mechanism for coping with reduced personal resources. However, more recent studies have found that reasons for driving avoidance may be associated more with lifestyle or preferences than self-regulation, *per se* (Molar, Eby, Charlton et al., 2013). Reports of changes in driving behaviour that could be misinterpreted as self-regulation have been found. Blanchard and Myers (2010) reported that visitors, personal or family illness, and special events were given as reasons for driving more or less than usual for a small group of community dwelling elders. Over a 4-year period, Braitman and Williams (2011) found that retirement or job loss accounted for driving 35 fewer miles per week, and that moving from a retirement residence into assisted living or a private home with family resulted in a reduction of 61 miles per week. Few of the older drivers in this study had medical conditions that might impair driving and require compensation, and thus account for the decreased mileage. However, the oldest drivers who perceived memory and physical mobility impairments did avoid more driving situations. The average miles driven per week

decreased from 94 to 78, and the mean number of driving situations avoided increased slightly from 2.5 to 2.9 (out of a possible 10). However the pattern was not linear; the average number of driving situations avoided increased during the second year but decreased during the third suggesting other factors may have influenced these driving behaviour changes.

There has been a considerable amount of work, more recently, considering the contribution of psychosocial factors to driving self-regulation. Attitudes of confidence and feeling comfortable with driving have received attention and have been shown to be more predictive of self-regulation than declining health or on-road driving performance (Baldock, Mathias, McLean & Berndt, 2006). This research has been rooted in Bandura's social cognitive theory wherein self-efficacy is theorized to be a stronger determinant of behaviour than the individual's actual skills or abilities (Bandura, 1986).

Siren and Meng (2013) found a linear relationship between driver discomfort and driving avoidance. The driving situations most likely to be associated with discomfort reflected inner states, such as "feeling unwell" or "feeling tired", or with external conditions, such as "when it is slippery" and "when it is dark", but not with situations related to specific road types or infrastructure. Likewise, driving avoidance mainly occurred in relation to inner states and road conditions but not infrastructure, possibly because infrastructure is difficult to avoid during travel. Myers, Paradis & Blanchard (2008) examined older drivers' confidence in their own abilities, as well as discomfort with other drivers, as a mediator between declining abilities, associated problems, and self-regulation. They developed a 13-item driver confidence scale for daytime driving and a 16-item scale for nighttime driving. Older drivers, who have been repeatedly found to have higher levels of self-regulation, were more likely to score low on night versus daytime driving confidence. Further studies on a small sample of older drivers (Blanchard & Myers, 2010) found good correlation of the comfort scales to self-rated driving abilities, and drivers who scored below the midpoint of the comfort scales were significantly more likely to restrict their driving. An expanded study of 928 older drivers confirmed these findings; the more comfortable older adults felt about driving , the more kilometers they reported driving, and in more driving they did in challenging situations. Older adults who felt less comfortable

behind the wheel said they avoided more challenging driving situations and actively restricted their driving (Jouk, Tuokko, Myers, et al., 2014).

Finally, decisions to self-regulate driving have been found to be influenced by the individual's attitudes about self as well as about others. Tuokko, McGee & Rhodes (2006) defined negative (Con-) and positive (Pro-) attitudes about self and others as correlates of driving. Negative views of self include statements about how driving is becoming more difficult, stressful or expensive. Negative views of others include statements that others think their driving is not as good as it should be. Conversely, positive views of self reflect the need to continue driving for intrinsic reasons, and positive views of others reflect beliefs that others want them to continue to drive, or to not stop driving. Those reporting more negative attitudes were more likely to be actively restricting their driving, and those who reported more positive attitudes were less likely to be self-restricting. Effect sizes were small to medium. When applied to the larger Canadian Candrive II study (N=928), drivers who had more negative views about driving were similarly more likely to drive fewer kilometers per year and to avoid more challenging driving situations, underscoring the contribution of psychological and psychosocial factors, in addition to health and personal resources, that affect driving decisions (Jouk, Tuokko, Myers et al., 2014).

The effect of driving avoidance on crashes has had mixed findings. Owsley, McGwin, Phillips and colleagues (2004) found no effect of self-regulation on crash rate. Ball et al. (1998) and Charlton, Oxley, Fildes and colleagues (2003) noted that drivers who reported avoiding certain situations were more likely to have been involved in a crash. On the other hand, Baldock and colleagues (2006) and De Raedt & Ponjaert-Kristoffersen (2000) determined a positive effect on crashes. De Raedt & Ponjaert-Kristoffersen (2000) offer the explanation that drivers' immediate goal of self-regulation is to reduce mental workload, and that increased safety is a by-product of the compensation behaviour rather than the main goal.

One study examined a sample of older drivers who had been referred for a driving test because of prior crashes, on advice of a doctor, or because their license had lapsed. None were suspected of having cognitive impairment. It was found that the drivers who had no history of crashes self-reported significantly more avoidance of difficult driving

situations than those who had had a crash within the past year. When examined on-road, the drivers who scored as “average” or “good” on the road test used more tactical compensation strategies such as driving slower and increasing their gap. These drivers did not have a history of crashes. The authors concluded that drivers who select lower-risk driving situations and compensate by adapting their driving style cause fewer crashes than those who do not adjust their driving (De Raedt & Ponjaert-Kristoffersen, 2000).

Promoting driving avoidance as a strategy to reduce crashes fails to take into account older drivers’ goals and motivations such as accessing essential services and maintaining social connections (Hatakka et al., 2002). Older drivers may engage in other behaviours, besides self-regulation, to reduce their risk. These behaviours are usually not revealed by questionnaires that ask about driving avoidance. For example, older drivers might compensate for poor night vision by travelling along streets with better lighting, or by travelling only along very well-known routes where they feel confident the hazards are minimal.

3.3. Decision-Making and Aging Research

The study of judgment and decision-making has developed in the fields of economics, business, medicine, and law. Two basic strategies have emerged in studies of risk and uncertainty: laboratory experiments of framing using games and gambling tasks, and studies of processes controlling behaviours of risk populations (e.g., stock brokers, physicians). Laboratory studies may be criticized for not being representative of everyday decisions, and risk populations are likely to have unique characteristics that are not representative of all individuals. Older drivers may be considered a unique risk population with regards to driving and may not follow the same decision pathways as other risk populations. Recently, studies have focused on the younger age groups in applied studies such as reckless driving but little has been done with older adult driving risk. Reyna (2008) notes that current theories of decision do not take into consideration all the relevant aspects of aging and age-related decline that impose constraints on older adults. For example, decision theories assume individuals compare alternatives by judging the risks associated with each alternative and choosing the most advantageous course of action. However, cognitive decline in older adults may preclude this process by altering working

memory and divided attention so that the individual relies primarily on habit rather than on rational choice.

A growing body of evidence supports the existence of changes in problem solving with aging. Blanchard-Fields et al (2007) has found that older adults are more likely than young adults to choose proactive strategies and directly confront instrumental problems. However, in dealing with personal problems, older adults choose passive emotion regulation and avoidant-denial strategies. Older adults are more focused on current emotional satisfaction and rely more on emotional processing than on analytical processing. They try to avoid negative affects when making a decision and remember their past decisions in a more positive light (Zamarian et al., 2008). Studies including brain imaging (Wood & Kisley, 2006; Kisley et al., 2007) have demonstrated that in older adults, neural reactivity to negative images is reduced. There is a tendency for humans to pay more attention to negative information than to positive information, resulting in “negativity bias” in making decisions. In older adults this negativity bias is reduced, effectively increasing the use of positive information in decision-making. Results of this reduction in negativity bias may manifest itself in preferential focus on positive rather than negative aspects of driving. For example, an elder may focus on the emotional rewards of driving and ignore aspects such as the driving task’s associated heavy mental workload. However, this prediction is not supported by Tuokko and colleagues (Tuokko, McGee and Rhodes, 2006) who demonstrated that older adults who had more negative views of their own driving, and driving in relation to others, were more likely to consider driving restrictions, and this effect increased over time.

Previous studies have demonstrated that older adults tend to be more overconfident in their decisions than younger adults (Keren, 1991). Ratcliff et al. (2004) found that older adults require more evidence to make a decision suggesting increased cautiousness in responding to situations. Using laboratory studies, Spaniol & Bayen (2005) showed that age-related deficits in memory encoding resulted in lowered accuracy in judging the frequency of an event. Judging an event as occurring more frequently would increase the saliency of the information in making decisions. This effect was reduced when more study time was given, illustrating that elders are capable of making equally correct judgments as younger adults if given enough time. Wood et al (2005) found that both

younger and older adults were successful at solving the Iowa Gambling Task but used very different strategies. Whereas younger adults used learning and memory, older adults relied on higher levels of accuracy (valence) by not over-emphasizing the impact of losses compared to gains. For the older adults, choices were highly dependent on recently experienced outcomes rather than the outcomes producing the maximum expected payoff. Applied to driving, this suggests that elders may heavily weight their most recent driving successes in making subsequent decisions. “I drove to the store just fine yesterday” may be used to justify a decision to drive today, despite changes in weather, health, or other factors that could impact success.

Cognitive changes in aging may be precipitated by illness, and some studies have demonstrated the effects of age-related medical conditions on decision-making. Thornton and colleagues (2007) found that patients with chronic kidney disease performed worse on measures of everyday problem solving and exhibited poorer memory and executive abilities. Paterson et al (2002) found that although individuals with different chronic diseases shared similar elements in their self-care decision-making, they differed in the perceived meaning and significance of their decisions. These differences depended on attributes such as timeliness, social context and available information. Pinquart & Duberstein (2004) found older cancer patients preferred to receive less information and were less likely to analyze all relevant information in order to make an optimal decision about their treatment. For HIV adults, reduced performance on a gambling task was correlated with tests suggesting the role of inhibitory processes and verbal memory (Hardy et al., 2006), and for patients with Parkinson’s disease, frequency of disadvantageous choices correlated with both executive functions and feedback processing (Brand et al., 2004). It is likely, then, that the health status of the older individual would have impacts on decisions about driving. In addition to affecting decision-making abilities, successful driving is also highly reliant on adequate memory and executive function. The combination of altered cognitive decision-making abilities with reduced cognitive skills required for driving may contribute substantially to poorer driving decision outcomes.

It is recognized that some older individuals preserve decision-making abilities while others show a marked decline. This may be manifested in the variability of older adults’ driving self-regulation. Whereas some elders decide to avoid challenging driving situations

on a regular basis, others continue to drive under all conditions regardless of their increased risk from declining abilities (Baldock et al., 2008). It has been suggested that older adults' vulnerability to misleading information, resulting in victimization, is related to the cognitive decline with aging (Denburg et al., 2007). Compared to younger adults, older individuals show poorer learning of new information, less efficient working memory and reasoning skills, slower processing speed, and higher susceptibility to interfering information. This effect may be especially salient for older drivers encountering changes in roadway geometry. In fact, some older drivers report difficulty dealing with road engineering changes such as roundabouts and new road signage (MacGregor et al, 2001; Texas A & M Transportation, 2013). Age-related effects are especially evident on tasks requiring executive functions such as selecting and attending to information, task switching, or flexibility distributing mental resources because of changes in the prefrontal cortex (West, 1996). However, studies of cognitive aging effects on decision-making have had mixed results. In a meta-analysis of studies examining age differences in everyday problem solving and decision-making, Thorton & Dumke (2005) found methodological differences between studies accounted for variations in results. The content of the problems presented and the educational level of the older subjects were found to influence the magnitude of age differences. For example, Zamarian et al (2008) found older adults had poor performance on the Iowa Gambling Task under ambiguous conditions but not for the Probability-Associated Gambling task under risk conditions. Given that context may play an important role in decision-making, especially for elders, the influence of others such as nominated persons may become more important.

3.4. Decision Context

Ronnlund et al. (2005) have demonstrated that the manner in which problems are presented (framing effect) has different impacts on decisions for different scenarios. That is, Ronnlund and colleagues found that both younger and older adults were more susceptible to framing effects for life-death scenarios than for scenarios involving personal money or public property. Tversky & Kahneman (1981) refer to "decision frames" as the individual's conception of the acts, outcomes, and constraints associated with a particular choice. In other words, the individual makes decisions within a specific context. People

value a certain gain more than they do a probable gain with an equal or greater expected value; the opposite is true for losses.

Two phases of decision-making are distinguished: the first phase in which the context is perceived and the problem is framed, and the second phase in which the evaluation occurs. Context, therefore, is comprised of individual perceptions and may not always accurately reflect a situation.

The perceived context of an individual can be changeable and can affect behaviour outcomes. Two important principles are relevant. First, the individual may consider a problem within a positive or negative context, which can result in either risk-aversion or risk-taking behaviour (respectively). Second, individuals perceive losses more strongly than gains, so that the difference between options will be perceived as greater if the problem is stated as a disadvantage of one option rather than as an advantage of another option. Combined, these principles affect decisions. For example, not driving may be felt more strongly if it is framed as a loss of the ability to drive rather than as an opportunity to share time (ride with) a friend. This may result in a shift from risk-taking behaviour (e.g., driving in bad weather) to risk-aversion behaviour (accepting rides from others).

Tversky & Kahneman (1981) state that, “the adopted decision frame is controlled partly by the formation of the problem and partly by the norms, habits, and personal characteristics of the decision-maker”. The information used to make decisions is thus influenced by context. As an example, a healthy experienced driver may consider driving in a positive light because of a prior history of successful driving, social expectations of driving, and perceived ability to drive, and may consider only information about road conditions in subsequent day-to-day driving decisions. In contrast, a frail driver may consider driving in a negative light because of a recent crash, urgings of others to give up driving, feelings of discomfort with poor road conditions, and may consider physical health most often in deciding whether to drive. It is therefore important to understand how the context within which driving decisions are made influences the information used in making risky versus risk-avoidance decisions.

Whether an individual frames a problem in a positive or negative manner is also influenced by their perceptions of social norms and constraints. Guided by the work of

Velicer, DiClemente, Prochaska and Brandenburg (1985), Tuokko, McGee and Rhodes (2006) identified 32 items reflecting positive and negative social norms of driving in relation to self and others. Pro- items included, for example, “By driving, I can support nominated persons and friends”, while con-items included, “People close to me disapprove of my driving”. Other positive and negative constraint items may be, for example, “my reflexes are still quick enough to handle a sudden stop” and, “there are too many bad drivers on the road now”. Although evidence supported the common notion that self-awareness of deficits is a strong motivator for alterations in driving behaviour, Tuokko found that external factors such as environmental demands also affect decisions. In their study, most older adults said they would consider changing their driving behaviour “under certain circumstances,” again supporting the notion that context plays an important role in decisions about driving.

3.5. Information Components

The type of information used by elders to make driving decisions may be classified into different components. Steg, Vlek & Slotegraff (2001) identified *symbolic-affective* versus *instrumental-reasoned* motives for car use and examined their relative importance. Instrumental-reasoned motives include items such as “it has carrying capacity”, that is, a vehicle is instrumental in helping to move heavy, bulky, or a lot of items. *Symbolic-affective* motives include items such as “I am just a bit in love with my car”. When asked directly to evaluate the attractiveness of car use, respondents especially mention *instrumental* aspects. Similar results are found in the literature on older drivers wherein the focus of responses has generally been on driving as a functional activity, for example, for shopping or attending doctor’s appointments. However, Steg found that *symbolic-affective* factors were major motivators of car use. Stradling, Meadows and Beatty (1999) also demonstrated that individuals who more strongly value aspects such as being independent and maintaining a sense of personal identity from driving a car were less inclined to reduce their car use.

Steg et al (2005) applied Dittmar’s (1992) model of material possessions to car use. This model states that material possessions, such as cars, represent both *instrumental* and *symbolic* values. Symbolic values refer to person identity and are twofold:

the expression of self, and a social-categorical expression indicating one's social position or group membership. Furthermore, Dittmar contends that the use of material possessions fulfills three functions: *instrumental*, *symbolic*, and *affective*. Car use may thus have an *instrumental* function (it enables activities), a *symbolic* function (a means to express self or social position), and an *affective* function (deeper, emotional, non-instrumental needs and desires). The significance of these three motives may vary for different groups of people, and an understanding of these differences may have important implications for transport policies and programs.

Dittmar's model and the work of Steg identified five major components of car use: symbolic value, instrumental value, freedom to move, negative environmental factors, and negative safety of car driving. For this research a sixth component, habit, is proposed.

3.6. Habit

As individuals move through time and space, they could be faced with an overwhelming number of small decisions, each of which would require cognitive energy. To reduce the cognitive workload, a lot of behaviour becomes habitual (Johnson, 1990). Behaviours such as dressing and eating are carried out routinely without conscious decisions about, for example, which arm to put into a shirt first or how to get a piece of fruit into the mouth. Habits are commonly understood as "learned sequences of acts that become automatic responses to specific situations which may be functional in obtaining certain goals or end states" (Verplanken et al., 1997). Responses that occur within similar contexts are carried out in the absence of formal, conscious decisions. Triandis' (1980) model of attitude-behaviour relationships recognizes the role of habit and states that intentions are assumed to predict behaviour to the extent that the habit component is weak, or to a lesser degree, when habit is strong. Liebenstein (1981) distinguished between "active" and "passive" decision-making by describing the individual as being in a "holding pattern" of behaviour until an event is potent enough to make one realize that an active decision is needed. Driving has often been described as an habitual behaviour, not only in performing driving maneuvers such as steering a vehicle, but also in, for example, what route to take. Only when a potent event occurs to change the context of the decision (e.g., road closure; illness) is the individual likely to make a conscious driving-related

decision – a concept referred to as *habit discontinuity hypothesis* (Verplanken, Walker, Davis & Jurasek, 2008)

It is generally agreed that people use information to make decisions, but the amount and type of information, and the processes used is less clear. The economic view of decision-making as a rational process has been widely debated. Meeker (1980) states that the most irrational aspect of the decision-making process is the limited number of behavioural options that individuals perceive. That is, individuals usually consider only a few ideas of how they could handle a situation. Simon (1956) describes most decision-making as “good enough” decisions wherein the individual considers only a limited number of options using minimal information to reach a decision that meets “good enough” standards of outcomes. This “good enough” approach is inconsistent with the economic model of decision-making wherein the individual attempts to maximize benefits for every decision by weighing all possible alternatives. However, the “good-enough” hypothesis is consistent with the belief that people generally engage in habitual behaviour to avoid the mental work of examining all alternatives. We also know that as individuals age the capacity for mental workload that affects driving diminishes (Schlorholtz, 2006), increasing the likelihood of using the “good enough” approach.

Studies of car use (e.g., Verplanken & Orbell, 2003) have demonstrated its habitual nature. Triadis (1977, 1980) declared that the repetition of actions results in habitual behaviour and that the frequency of past behaviour is the best predictor of future behaviour. However, more recent definitions have underscored that habitual behaviour occurs as automatic responses to specific cues, and are functional in obtaining certain goals or end-states (Verplanken & Aarts, 1999). Thus the existence of both consistent goals and stable contexts are seen as necessary conditions for habitual behaviour.

There is evidence in the literature that health status represents a changeable context that may affect driving decisions. For example, older adults have reported that declines in vision contributed to their decision to cease driving (Owsley et al., 2004). Economic pressures and advice from others have also been cited as an influence on driving cessation (Johnson, 1998). These changes represent threshold events that can trigger a shift from habitual behaviour to more conscious decision-making. However,

evidence has also demonstrated that despite significant changes in vision, economic circumstances, or advice from others, driving habits persist for some individuals.

3.7. Family Influence

Very little is known about the role of the family in the driving decisions of elders. Although older drivers generally insist they make their own decisions about driving, some also admit that they would likely listen to the opinions of others (Johnson, 1998). For some, a spouse plays a major role especially when the spouse is also a driver and can provide the needed transportation (Oxley et al., 2004). A decision to stop driving represents a major life event in that it has impacts on lifestyle as well as social and family relationships. Major lifestyle decision-making in older adults has been studied primarily in the domains of medical care and living arrangements. Within both domains, the family is often found to play a prominent role, especially among widowed older adults. Caregiving daughters, for example, have been found to be highly influential in their mothers' decisions about health, finances, and housing (Pratt, Jones-Aust & Pennington, 1993). However, very little is known about the influence of nominated persons on the driving decisions of elders. Whereas Rudman, Friedman, Chipman, and Scirotino (2006) found that seniors (especially widowed) thought that their children could play a role, Persson (1993) found that nominated persons had limited influence on an elder's decision to quit driving. Even though nominated persons offered advice and alternatives to driving, it was made clear that the parents themselves would make their own decisions. This is in contrast to the findings of Lambert et al. (2005) who found that in a medical setting, older adults prefer to have input from professionals and family in a shared decision-making model.

It is assumed that in general, the individual will base considerations about driving on their own experiences and self-evaluations. However, recent conversations with others, especially family, may influence how the individual self-evaluates. Comments made by adult children may provide triggering events that prompt a switch from habitual to reasoned driving behaviour. For example, an individual may initially assume reaction speed is adequate for driving and thus not include it in decision-making. But following a comment by a daughter about becoming slower, doubt may threaten this assumption and cause the individual to assign it more weight to reaction time in future decisions. In support of this

notion, research has shown that individuals increase their self-regulation of driving after receiving feedback regarding their visual and other driving abilities (Ackerman et al., 2011; Eby et al., 2003; Holland & Rabbitt, 1992; Owlsey et al., 2003).

The work of Kostyniuk et al (2009) with adult children of older drivers found that relatives have concerns about older drivers and sometimes engage in conversations for the purpose of influencing driving decisions. Main strategies for influencing the parent were to offer rides, point out increasing functional limitations of the parent, express concerns about safety, refuse to ride as a passenger, and in extreme cases intervene to remove the vehicle or have the license revoked. These findings are consistent with Connell et al (2012) who also reported that discussions about driving and changes in driving decisions made by elders were typically triggered by a serious illness or health decline. They found that some adult children introduced ideas about driving alternatives to influence parents towards a new decision-making processes. In some cases, adult children took the decision-making process away from the parent, for example by hiding the car keys or involving licensing authorities. On the other hand, some in cases the adult child encouraged the parent to continue driving, although the process through which this was done was not described.

Summary

Safe driving requires that the individual has adequate resources to meet the demands of the driving environment. As age progresses, individuals typically experience changes in physical as well as cognitive resources that affect driving-related abilities, such as vision, strength, flexibility, working memory, and executive function. Some drivers, themselves, report attempting to compensate for these changes by modifying their driving behaviours and/or reducing the amount of driving they do, but with mixed results. Industry strategies to support continued driving include refresher driving courses, cognitive training, licensing restrictions, and in-vehicle crash avoidance technology, although the success of each of these in reducing crashes is as yet not clear.

Aging has also been associated with changes in decision-making that can ultimately affect older driver’s exposure to risk. However, little is known about how driving

decision-making occurs, at any age, or how it is affected by age-related changes. There is some evidence to suggest that elders may focus more on emotional components in their driving decisions, and that attitudes play a major role compared to risk assessment. *Symbolic-affective* motives such as personal identity and pleasure may play a more prominent role than *instrumental-reasoned* motivations such as convenience and safety, at different times in the lifecycle. Furthermore, the changing context within which decisions are made, such as poor health, may alter decision patterns. Family members may also play a mediating role through providing alternate transportation, encouragement to continue driving, or criticism. On the other hand, the highly habitual nature of driving may override many or virtually all of these influences. The current research aims to clarify some of these questions.

Chapter 4.

DEVELOPMENT OF DYNAMIC DRIVING MODELS

One of the best ways to demonstrate understanding about a subject is to illustrate the main constructs in a model or framework. A conceptual framework is an analytical tool that organizes ideas and makes conceptual distinctions. It provides a rationale for the study of a subject area and aids understanding of the research perspective. Theoretical frameworks outline assumptions, connect existing knowledge, and transition from simply describing phenomenon to specifying key variables that influence the phenomenon.

To guide this research, dynamic models of driving were developed prior to undertaking the research, drawing on the integration of the theoretical perspectives described above (Section 2), and on a review of the literature. These models were developed from an understanding of issues about older drivers and were used to provide guidance and structure for the research. Results of the research were used to refine the models as presented in the Discussion section of this thesis (Chapter 8).

Driving Decision Process Model

Figure 3 introduces a conceptual model of the driving decision process that integrates P-E fit models and Behavioural Decision Theory. At the top of the proposed model, behaviour is motivated by a need or want for transportation. For many, this motivation is immediately followed by habitual behaviour of driving where no conscious deliberation or decision-making occurs. At the left side of the model, aging and situation changes represent changing personal and environmental components similar to those of P-E fit models. The dashed line illustrates how the need/want precipitates consideration of these factors which, together, may be conceptualized as forming a decision frame as described in decision-making models. For older drivers, aging changes and situation changes are believed to trigger an awareness of the need for an active decision. This active decision-making interrupts habitual behaviour as illustrated by the broken line. Age and situation triggers may affect the individual directly or through influencers such as nominated persons and friends who call attention to these triggers. The individual

integrates selected information in deliberating a decision, which is in turn assumed to be followed by the decided behaviour. In the model, a dotted line is used to illustrate a feedback loop wherein age-related changes may moderate the need or want.

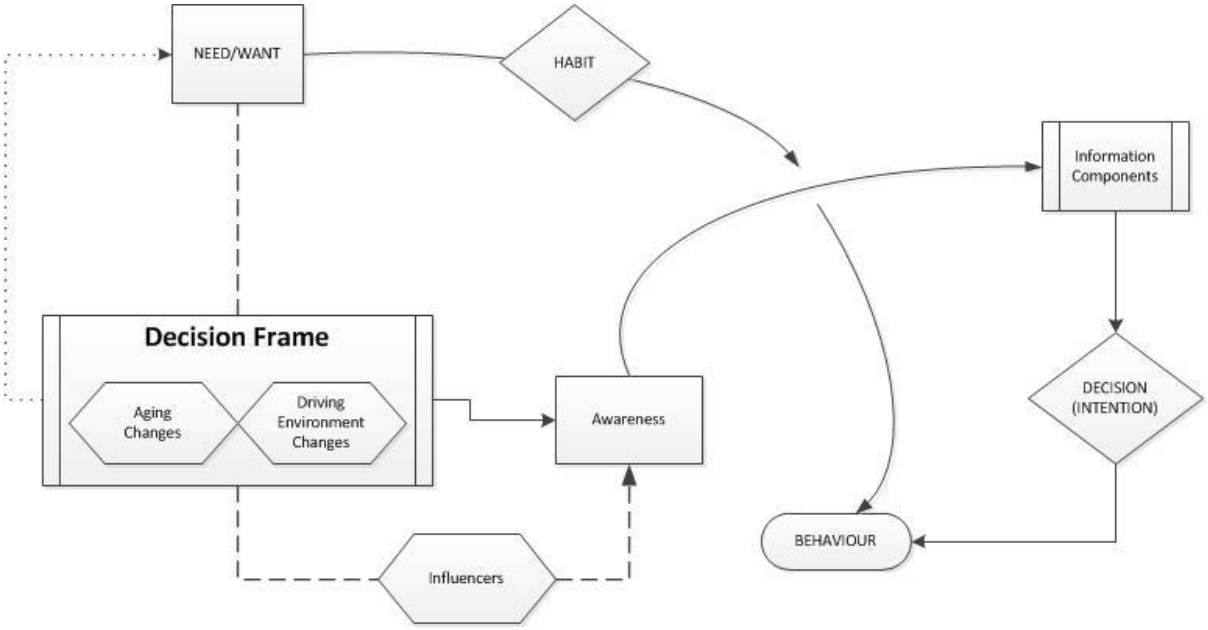

Figure 3. Conceptual Driving Decision Process Model

As an example, an individual identifies a need to attend a medical appointment. Under usual conditions the individual picks up the car keys and drives to the doctor's office as on many previous occasions, displaying habitual driving behaviour. However, age-related changes have resulted in a gradual decline in vision in this individual. If the individual is unaware of these changes the habitual driving continues. But suppose the individual has just noticed that road signs are more difficult to read while driving, or suppose the individual had recently been told by their optometrist (an influencer) that their vision has declined. Awareness of the need for a more conscious decision process is raised. But only when a threshold level stimulus is reached does the individual become aware of the need for a conscious decision. Rather than following the habitual pathway the individual now questions the status quo and proceeds along a decision-making pathway. Along this pathway various information components are considered including

those within the decision frame and the influencer. Depending on the information selected and the process used in comparing alternatives, the individual decides either to change behaviour or to repeat the routine behaviour. Habit strength for driving in the previous manner is thus reduced.

4.1. Older Driver Decision Components Framework

The above proposed model describes two pathways along which driving behaviour occurs. Figure 3 proposes a framework for the Information Components illustrated in the Driving Decision Process Model. These information components are conceptualized as types of information used in older driver decisions, which are organized into categories as illustrated in the model.

In developing this framework, an extensive review of the literature was used to reveal specific items that elders comment on concerning their driving. The literature on driving self-restriction and driving cessation was particularly useful in highlighting key elements used in making decisions. In developing the framework, the specific types of information were organized into categories according to whether they were associated with, for example, physical health, vehicle, or social aspects. These categories were then combined into three major components: *Motivators*, *Constraints*, and *Contextual Factors*.

First, the individual experiences *Motivators* that raise a need for transportation. In keeping with Decision Theory, the status quo (driving) is presumed. *Motivators* include instrumental aspects related to driving such as perceived need and convenience, as well as attitudes about driving such as appraisals of driving alternatives, driving habits, and emotions associated with driving. The second category is conceptualized as C*onstraints* that provide boundaries or obstructions to driving and includes mainly instrumental aspects such as not having a driving license, not having access to a vehicle, and poor health. *Contextual Factors* are defined as the social and personal environment within which the individual makes decisions, as described in section 3.3 above.

Within this decision framework, the individual is seen as considering *Motivators*, *Constraints*, and *Contextual Factors.* In many instances these three components remain relatively consistent over time, so that the "decision" to drive is largely habitual. For example, the desire to attend a fitness class (a *Motivator*) may arise weekly, at a regular time of day, so that the traffic congestion (a *Constraint*) is largely the same each week and anticipated by the individual. Further, if the individual has not been involved in a recent crash, they would assume their driving skills are still intact (*Contextual Factors*). Since all of the component factors remain unchanged, the act of driving to the fitness class becomes a weekly habit. However, if a change in one of these factors occurs, and is considered by the individual to be significant, (e.g., a crash), an appraisal process is activated. The transportation decision becomes more deliberative. The individual will reconsider the three component factors, together, and make an assessment of the risk of driving versus not driving. This driving risk assessment is seen as a complex, multi-level process of weighing the benefits of driving to satisfy goals (maintaining fitness) versus the risks of negative outcomes (e.g., injury from a crash; negative appraisal of others). The relative contribution of factors to risk assessment is seen as variable, depending on the individual and on the particular circumstances of the decision.

The framework in Figure 4 illustrates the three major information components. The large arrows illustrate how these major components may influence each other during the decision process. That is, the individual's perceptions of *Constraints* may influence perceptions of *Contextual Factors* and vice versa. Anywhere along these pathways the individual may use information to make a driving decision as illustrated by the smaller arrows. For example, the individual may consider only *Motivators* and *Constraints* in their decision, or only *Motivators* and *Contextual Factors*. A heavier arrow connecting *Motivators* directly to the driving decision represents habitual driving behaviour wherein the individual bypasses information about *Constraints* and *Contextual Factors* altogether.

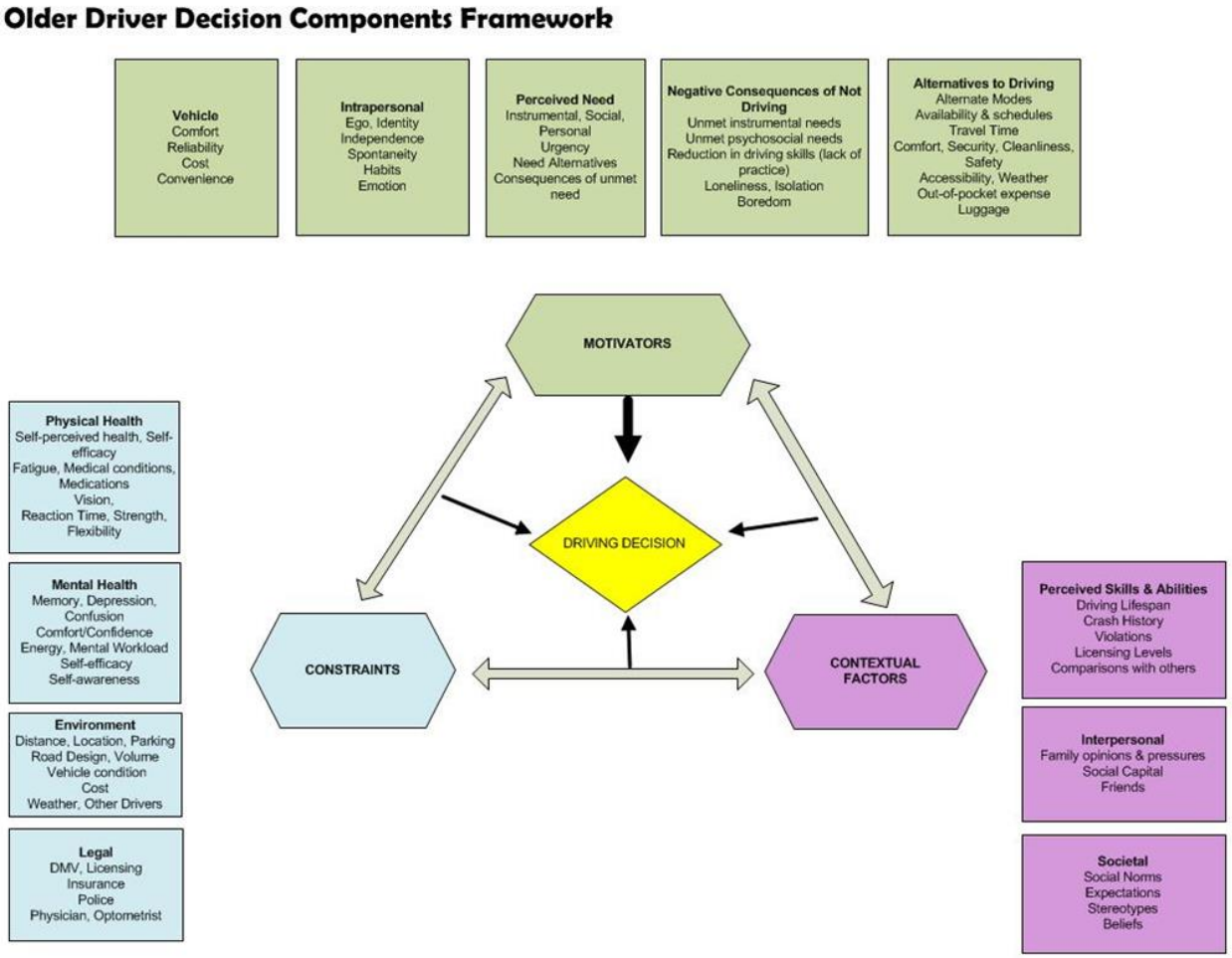

Figure 4. Conceptualized Older Driver Decision Components Framework

Chapter 5. **RESEARCH QUESTIONS**

5.1. Objectives

Since this study represents a new direction in research, it is exploratory in nature and hypotheses are not developed and tested in an experimental fashion. Instead, a series of research questions are considered, and from these questions, a main objective is formulated.

The main objective for this research is to explore the processes underlying day-to-day driving decisions of older adults, including whether or not they would drive, and under what conditions they would drive.

5.2. Key Questions

An overarching question was formulated to guide this research. The question is framed as a broad inquiry, containing a colon identifying four more specific constructs.

How do elders make decisions about whether or not they should drive: what attitudes, information, influences, and processes do they use in their decisions to drive?

The four constructs that contribute to the broader topic have been articulated for the purposes of this study. Included in *attitudes* are beliefs and feelings about driving, for example the individual's values about the importance of driving and their habit strength for driving. *Information* includes items of fact/perceptions about the elements of the driving environment as well as age-related changes that contribute to risk. *Influences* refer

specifically to comments others have made to the individual about their driving. And included in *processes* are the ways in which individuals consider, accept, reject, and combine the former in making decisions about driving.

To expand or understanding of driving decision-making among older adults, this dissertation examines the role and interrelationships of attitudes, external influences, information, and the dynamics of decision making processes in three key domains:

1) The Driving Environment
2) The Driving Decision
3) Social Influences on Decisions

For each of these domains, more targeted questions are considered in trying to add knowledge to the key question.

5.2.1. Q 1 – The Driving Environment

For each individual, driving occurs within an external physical environment (e.g., roadways, vehicles, weather) as well as a personal physical and mental environment. Given that aging results in personal declines that threaten the P-E fit for driving, in order to understand how this affects decisions, it is important to ask:

How do older adults perceive their driving environment and their ability to meet its demands?

This is a very complex question that has represented the focus of many studies on self-evaluation among older drivers (e.g., Horswill, Sullivan et al., 2013; Siren & Meng, 2013; Horrey, Lesch, Rubens & Lee, 2015). However, research has been mainly from the perspective of judging the validity of self-evaluations in relation to driving risk. The current research takes a non-judgement perspective in describing the use of self-evaluation information and environment-evaluation information from the driver's perspective. In other words, this research is concerned with how elders use ofself- and environment-evaluation information, rather than whether the evaluations are reasonable or not.

In developing a plan of enquiry, for this domain, several questions were considered. If elders modify their driving in response to changes in P-E fit, then it implies that they somehow evaluate the demands of the environment in relation to their own resources. The individual may measure their age-related changes by comparing to their past abilities or by comparing themselves to others, but what criteria do they use to evaluate whether these changes are relevant to their driving?

Several questions were considered in exploring the subject of how people think about driving. For example, is driving seen as a single entity that challenges them overall, or do they perceive different components that challenge different aspects of their personal resources? What are the underlying structures in how people think about driving, and what scale do they use to evaluate these structures?

These are likely difficult questions for many people to answer directly. Because driving is frequently described in terms of a single activity, it could be challenging for many people to verbalize how they perceive and evaluate different components of driving. To aid in this goal, this study uses a card sorting task to reveal the main components elders consider about driving, as well as a how these components are evaluated in relation to each other.

5.2.2. Q 2 – Driving Decision-Making

Decision Theory tells us that it is not possible for individuals to pay attention to every bit of information available to them. Instead, they select specific pieces of information and ignore others. A main question used to guide exploration into how elders make day-to-day decisions is:

What information do older drivers consider in making their decisions about whether or not to drive?

Individuals vary in their styles of decision-making, including differences in the types of information used and the weight placed on different items of information. The proposed models in Chapter 4 illustrate the breadth and complexities of information types relevant to decisions about driving. Researchers may want to know, are there specific dimensions

and types of information selected by different individuals in making their driving decisions? Are there types of information that dominate decisions? Do combinations of information increase the salience of specific items? Can elders be classified according to their different choices and their use of different types of information in their driving decisions?

Since everyday driving decisions could not be directly observed, choice scenarios are used to explore stated preferences for driving under different sets of driving and personal conditions. The choices made, and types of information used in making the decisions, are examined for patterns or styles of decision-making.

5.2.3. Q 3 – Influences on Decisions

As the resources of elders decline, families are sometimes challenged with the task of trying to convince a relative to modify their driving or stop driving altogether. This research explores:

How much influence do statements about driving have on older driver's decisions about whether to drive?

Whereas some verbal attempts to influence an elder may achieve the intended result, other attempts may either be ignored or have a contrary effect. Lines of enquiry could include, under what conditions do family and friends have an influence on the driving decisions of elders? Are there some types of statements that have more impact than others? Are there differences between groups of individuals with regards to the amount and type of influence? How do older drivers react to the comments of others? Do their reactions depend on the relationship with the messenger?

To explore these questions, older drivers in this study are asked about their reactions to comments about their driving. A statement sorting task is used to rate the amount of influence select statements about driving would have on them. These are related to group differences in decision-making.

Chapter 6. **METHODS**

This research uses a mixed methods approach, including qualitative interviews and tasks, and exploratory quantitative techniques. The advantages of quantitative approaches are that they: deliver accurate measurement of a specific construct; allow group comparisons; support examination of the strength of associations; and have the capacity for model specification and testing (Castro, Kellison, Boyd & Kopak, 2010). However, limitations of quantitative approaches are that they typically detach or decontextualize information from its "real world" context. Qualitative approaches, in contrast, contextualize information by examining the whole person holistically within the natural environment, delivering benefits of: generating rich detailed accounts of human experiences; examining information within its original context; and allowing in-depth analysis of complex systems that cannot be captured with measurement scales and statistical models (Plano Clark, Huddleston-Casas, Churchill et al., 2008). Limitations of the qualitative approach include difficulties in the reliable integration of information across observations or cases (Kirk & Miller, 1986), lack of well-defined prescriptive procedures (Morse, 1994), and difficulties generalizing results from small samples (Denzin & Lincoln, 1994). A mixed methods approach helps to capitalize on each method while at the same time compensating for the limitations of each.

In this research, an integrative mixed methods (IMM) design is used (Castro, Kellison, Boyd & Kopak, 2010) wherein the qualitative and quantitative data is collected during the same stage. A core feature of this approach is parallelism in study design, where integration begins with a unified conceptualization of information as "research evidence". Qualitative data thus allows a rich interpretation of the quantitatively derived results. Under the IMM approach, the main aim is to generate "deep structure" conclusions (Castro & Nieri, 2008) that offer explanatory power above and beyond the sole use of a qualitative or quantitative approach (Castro et al., 2010).

This study was approved by the SFU Office of Research Ethics.

6.1. Sample Recruitment

A convenience sample of 37 older adults was recruited through advertising at community recreation centers, senior's centers, community bands, a low income senior's housing complex, and through word of mouth in the Vancouver metropolitan area. Several of the participants enjoyed being in the study and encouraged friends to contact the researcher (snowball sampling). Inclusion criteria for the research was age 70 years and older, a valid driver's license, actively driving at least one day per week, and proficiency in the English language. Interested candidates were contacted by phone or by email and a convenient date and time to meet was scheduled.

All participants read and signed an informed consent approved by the SFU Office of Research Ethics prior to commencement of the research.

6.1.1. Questionnaires and Scales

After signing an informed consent, participants completed brief questionnaires (see Appendices A, B, C). These questionnaires were used mainly in a qualitative way to describe characteristics of groups of participants. The questionnaires covered three main topics:

1) Demographics – e.g., living arrangements, education, income
2) Health – e.g., self-rated health, limitations to activities, diagnosed illnesses
3) Driving – e.g., amount of driving, self-rated abilities, driving avoidance

Participants also completed the following scales and tests (see Appendices D, E, F, G). Because the research required participants to use memory and executive function, they were screened for cognitive deficits using the Folstein Mini Mental State Exam (MMSE) (Folstein et al., 1975). Individuals with cognitive impairment, as defined below, were considered unsuitable for inclusion in the study.

1) Mini-Mental Status Examination (Folstein et al., 1975)

2) Self-Reported Habit Index (SRHI) modified for driving (Verplanken & Orbell, 2003; Gardner, 2009)

3) Modified Interpersonal Relationship Scale (Garthoeffner et al., 1993), abbreviated version (MIRS-A)

4) Timed Up and Go (TUG) (Mathias et al., 1986)

Due to small sample sizes, results were used mainly to qualitatively describe participants in the study. These scales were completed at various times during the research, often between study tasks, to give participants a break from sitting. Responses on the questionnaires were tabulated and used for descriptive purposes. Some qualitative comparisons were made between different groups of participants.

Demographics Questionnaire

A 15-item questionnaire was developed to obtain information from participants that would be relevant to their driving behaviours, including living arrangements, transit use, employment and income. Studies have demonstrated a key determinant of travel behaviour is household composition and living arrangements. Availability of family members or friends to provide transportation can have a significant effect on amount and type of driving (Cohen, 2013; Morris, Howard, Fries et al., 2014). Age and gender (Kostyiuk & Molnar, 2008; Ragland et al, 2004), employment including volunteer work (Siren & Meng, 2013; Curl, Stowe, Cooney & Proulx, 2014), as well as income and financial restrictions (Grengs, 2010; Nauman, Dellinger & Creswell, 2011; Wong, Smith, Sullivan & Allan, 2016) impact amount of driving. Location, especially rural residence, often determines availability and distance to public transport (Burkhardt, McGavock & Nelson, 2002; Hess, 2012), which in turn affects the need to drive to access services and maintain social connections.

Health Questionnaire

A 10-item questionnaire was constructed to document participants' self-reported health conditions that may impact their driving decisions. The questions asked about functional limitations, pain, medications, diagnosed medical conditions, and self-assessments of health status. Numerous studies have documented a relationship between health and driving. In a comprehensive review of the scientific literature, Dobbs

(2005) identified several categories of medical conditions that potentially impact driving, including vision, hearing, vascular diseases, respiratory, metabolic and renal diseases, musculoskeletal disabilities, and psychiatric disorders. However, many studies find that older drivers' self-ratings of health are more predictive of driving than actual diagnoses of medical conditions (Ackerman et al., 2010; Dellinger et al., 2001). Nonetheless, functional limitations, cognitive impairment and declines in vision (MacLeod, Satariano & Ragland, 2014) as well as psychological health (Davis et al., 2016) have been found to be significant predictors of driving behaviour. Medications used to treat medical conditions can also have a significant impact on self-regulation of driving, especially among women (Rosenbloom & Santos, 2014).

To reduce the mental workload on participants, and because participants' responses would be used for descriptive purposes only, existing health questionnaires were not used in their entirety. However, some questions were used to guide development of the questionnaire used in this study.

Driving Questionnaire

A 17-item questionnaire was constructed to document participants' driving history and behaviours, for description of the sample, and to validate participants' driving status. Items included the amount of time spent driving, questions pertaining to their driving comfort and style, avoidance behaviours, and crash and violation history. The literature on older drivers contains a vast number of studies that ask questions about driving behaviours, especially about self-regulation. The Driving Habits Questionnaire (DHQ) (Owsley et al., 1999) and the Driver Mobility Questionnaire (DMQ-A) (Baldock et al., 2006) are the most commonly used. To reduce the workload on participants, these questionnaires were not used in their entirety in the current study, however, items from these questionnaires were included. Items about driving confidence, demonstrated to be very predictive of driving exposure (Blanchard & Myers, 2010), were included.

MMSE (Mini Mental State Exam)

Participation in this research required participants to recall past events, remember instructions, and verbalize thought processes. These requirements necessitate adequate executive function. Individuals with moderate cognitive impairment are challenged with

attention and short term memory, and may be unable to meet the demands of the research tasks. The MMSE was used as a screening tool for inclusion in the research.

The Mini Mental State Exam (MMSE) (Folstein et al., 1975) is a recognized standard for quickly evaluating cognitive status. It was used to predict ability to participate in this research, using a minimum score of 21 as a cut-off value. This cut-off score was selected because an unadjusted score of 21-26 indicates mild impairment wherein individuals would be expected to be able to participate in the research. Crum et al (1993) also noted the effects of age and education on lowering the cut-off values, and since this research included an older population, a value of 21 was selected to allow individuals with mild impairment.

The MMSE has been found to be a poor predictor of on-road driving test outcomes and is not recommended as a stand-alone screening tool of driving performance (Crizzle, Classen, Bédard et al., 2012).

SRHI Habit Strength for Driving

The traditional method of measuring habit strength is through the measurement of the frequency of past behaviour. For driving, self-reports of the proportion of journeys made by driving are often used to measure the frequency of past behaviour, so in measuring habit strength, the proportion of driving journeys is used together with self-reported intention to repeat the behaviour (Ouellette & Wood, 1998).

A second method reported in the literature and used in the current research is Verplanken & Orbell's (2003) Self-Report Habit Index (SRHI) modified for the driving context (e.g., Gardner, 2009). The index is a 12-item measure of automaticity (8 items), frequency (3 items), and relevance to self-identity (1 item) measured using a 5-point Likert scale. The SHRI has been tested across four studies (Verplanken & Orbell, 2003). The instrument showed high internal reliabilities across all four studies, with alphas across test administrations of .89, .92, .89, .94, .95, .94, and .85. Measurements separated by one week showed high test-retest reliability, .90 ($p < .001$).

The SRHI has been used to measure the effect of habit on behaviour for physical activity, diet, travel by bicycle (Gardner et al., 2010), holiday travel (Bjork & Jansson, 2008), and commuting travel (Gardner, 2009). However, it has not previously been used within the context of older drivers.

This measure was used to describe the automatic driving habits of the participants. It was compared against self-reported driving exposure of the participants.

TUG

The Timed Up and Go test (TUG) is a simple, quick and widely used clinical performance-based measure of lower extremity function, mobility and fall risk. Lower extremity function has been associated with more driving difficulties in elders (Tuokko, Rhodes & Dean, 2007). Risk of falls, assessed using the TUG test and other measures, has also been associated with slower response times and poorer driving performance in older adults (Gaspar, Neider & Kramer, 2013).

The TUG has been studied in elderly populations and in various pathological conditions such as in patients with Parkinson's disease and stroke. Owing in part to its ease of use, association with fall risk and sensitivity, the American Geriatrics Society, the British Geriatrics Society, and the Society of Nordic Geriatricians, among others, recommend using The TUG as a screening test for fall risk. Inter-rater reliability is very high among hospital in-patients (Podsiadlo & Richardson, 1991) (i.e. ICC = 0.99) and community-dwelling older adults (i.e. ICC = 0.98) (Shumway-Cook, Brauer & Woollacott, 2000). The TUG also possesses high test-retest reliability with 87% sensitivity and specificity. It has been suggested that a cutoff point of 13.5 s can serve as a threshold for identifying persons with an increased risk of falling.

Herman, Giladi & Hausdorff (2011) determined that the TUG is normally distributed and does not suffer from ceiling or floor effects in healthy older adults. Additionally, they observed a small but significant association between the TUG and tests of executive function.

In the current research, the TUG was used as a descriptor of overall physical status for driving.

MIRS-A

The Modified Interpersonal Relationship Scale (Garthoeffner, Henry, & Robinson, 1993) is a revision of the Interpersonal Relationship Scale developed by Schlein, Guerney and Stover (1990). It is a 49-item self-report measure. Participants answer items with a 5-point (or 7-point) Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The scale measures potential for intimacy and general relationship quality by its six subscales: Trust, Self-Disclosure, Genuineness, Empathy, Comfort, and Communication. Internal consistency (Chronbach's alpha) was .95 (Garthoeffner et al., 1993); test-retest reliability was established at .92 (Rappaport, 1976).

For the purposes of this research, the scale was used as a comparison between participants rather than as an absolute measure of the quality of relationships. Thus to reduce the workload for participants, 27 items were selected from the original 6 subscales (Appendix F). The resulting scale was labelled MIRS-A (abbreviated).

6.2. Qualitative Methods and Analysis

This research used exploratory qualitative methods. The aim of qualitative research is to understand and represent the experiences and actions of people as they encounter, engage, and live through situations. In qualitative research, the researcher attempts to develop understandings of the concepts under study, based as much as possible on the perspective of those being studied. The central purpose of qualitative studies is to contribute to a process of revision and enrichment of understanding, rather than to verify earlier conclusions or theory (Elliott et al., 1999).

Strengths of qualitative research include: (a) the capacity for generating rich detailed accounts of human experiences (emotions, beliefs, and behaviors) and (b) narrative accounts that are examined within the original context in which observations are made. Moreover, the qualitative approach affords an in-depth analysis of complex human, family systems, and cultural experiences in a manner that cannot be fully captured with

quantitative methods such as measurement scales and multivariate models. However, qualitative methods also have limitations. These include difficulties in the reliable integration of information across cases, a lack of well-defined processes, and the use of small unrepresentative samples. Results are therefore not necessarily generalizable.

The use of qualitative methods for this study was appropriate because of its exploratory nature. This study hoped to gain an understanding of the concepts under examination from the perspective of the study participants. Although some models have already been proposed (Chapter 4), they were used only as a guide in conducting the research; the intention of the study was not to test or validate the models, but to add richness of understanding for further development.

The qualitative methods used in this study were guided by phenomenological philosophy in striving to describe the experiences of the subjects rather than the event itself as it exists external to the individual. That is, the research here took the perspective of the individual with regards to their own driving, rather than an examination of driving from the perspective of another. The broadest definition for phenomenology is as a theoretical point of view advocating the study of the individual's experiences, and the underlying axiom is that human behaviour is determined by the phenomena of experience rather than by objective, physically described reality that is external to the individual (Cohen et al. 2007). Using phenomenology, the researcher identifies a phenomenon as an 'object' of human experience, and gives voice to it (Cresswell 2007). The current study sought to identify the lived driving experiences of elders and their experiences in making decisions about their driving, and to provide descriptions and understandings about their experiences in building a framework for exploration.

Early phenomenology, based on the work of Husserl (1931) and Heidegger (1962) was written at a theoretical level with an aim to produce accurate descriptions of human experiences. Phenomenology can be seen as a method or methodology to garner hidden meanings and the essence of experience for individuals, through the analysis of their spoken or written language. It "aims to focus on people's perceptions of the world in which they live in and what it means to them; a focus on people's lived experience" (Langdridge 2007, p.4). Husserl's approach involved the phenomenologist "bracketing" or suspending

one's beliefs to find the essence of the phenomenon, whereas Heidegger instead adopted the position of being in the world where contextual interpretation was sought and valued. Phenomenology defined by Husserl has therefore been termed "descriptive" while that of Heidegger has been termed "interpretive" or "hermeneutic". The current study takes the latter approach.

Hermeneutic phenomenology is focused on the subjective experience of individuals and groups (Kafle, 2011). It is described as a lived experience for researchers learning to "see" pre-reflective, taken-for-granted, and essential understandings through the lens of their already pre- understandings and prejudices (van Manen,1990). It attempts to capture the 'essence' of a phenomenon (Langdridge 2007; Laverty 2003). "The research produces knowledge in the form of texts that not only describe and analyze phenomena of the lifeworld, but also evoke immediate understandings that otherwise lie beyond their reach" (van Manen, 2014).

Traditionally, phenomenology has used in-depth interviews to collect data. However, van Manen (2007) suggests that there are many means of data gathering for the analysis of lived experience, and that phenomenologists can utilise a variety of data sources including their own personal experience. Hein and Austin (2001) remind us that "there is no one way to carry out phenomenological research since the specific method used depends … on the purposes of the researcher, his or her specific skills … and the nature of the research question and data collected" (Austin, 2001. p.2). Hermeneutic avoids method for method's sake and does not have a step by step method or analytic requirements. The only guidelines are the recommendation for a dynamic interplay among six research activities: commitment to an abiding concern, oriented stance toward the question, investigating the experience as it is lived, describing the phenomenon through writing and rewriting, and consideration of parts and whole (Kafle, 2011. p. 191). That being said, the output of phenomenological research is typically a deep, rich, text description reviewed and verified by the research participants, themselves.

A phenomenological philosophy was used to guide portions of this research to the extent that the research attempted to stimulate participants to reflect on the meanings of their driving experiences including their driving decisions. The questions in

phenomenological research are about meaning, and are not designed to be solved. Early in the development of this research it was found that participants had difficulty responding to open-ended questions such as, “What does driving mean to you?”, or “How do you experience making decisions about whether or not to drive?”. The initial in-depth interview method was consequently enhanced to include tasks that could indirectly reveal the lived experiences of the subjects. Engagement in these tasks helped participants reflect on their own experiences and express their thoughts without biased prompting from the researcher.

Methods used in this research diverge from a true phenomenological approach with the result that in total, the research methodology represents a broader, qualitative approach to initiating exploration into the lived experiences of driving decision-making. In particular, the products of this research are not the deep textual descriptions described by van Manen (1990). Nonetheless, the methods used do uncover hidden meanings of phenomena such as the experience of driving and the experience of receiving and interpreting messages from others. Since this research included outlining a framework illustrating the key elements of these lived experiences, the output included identifying elements that the participants gave meaning to throughout the study.

The methodology used in this study also diverged from traditional phenomenological studies in aggregating data into clusters. Whereas in classical phenomenological studies the views of all individuals are uniquely described and contrasted, in the current study clusters of individuals with similar (but not identical) responses were defined. This approach was undertaken to increase the generalizability of the findings to larger populations. Although it was recognized that the fidelity of the findings would be reduced, identifying characteristics of similar decision-makers would be more likely to produce information of practical significance for policy makers and program developers.

One goal of this study, therefore, was to discover the phenomena associated with decision-making that are important to individuals, and a phenomenological orientation served this purpose well. This area of research is now well position to explore the deeper meanings of these phenomena.

6.2.1. Personal Interviews

Semi-structured, private, individual interviews were conducted with participants in their homes. Interview techniques were used throughout the research to collect qualitative responses on the three main research questions. The interviews included discussions about the participants' attitudes and beliefs about driving, their own driving experiences, their driving decisions and decision-making, and their attitudes on statements others may make to them about their driving.

The discussions were initiated by a general question from the researcher, for example, "what does driving mean to you?" and "tell me about some of the comments others have made about your driving." Participants were encouraged to expand on their answers and reflect on their experiences and meanings, for example, by asking, "how did that make you feel?", "what was it about that other driver that bothered you?", or "what would it be like for you if you could not drive on that day?".

During the interviews, participants were asked to complete specific tasks designed to encourage them to think more deeply about driving. As they completed the tasks they were asked to express their thoughts aloud, i.e. to use a think-aloud protocol (van Someren, Barnard & Sandberg, 1994). Think-aloud is method used to reveal both the structure of the problem-solving process used by the individual, and the results of the problem-solving steps that are taken. During this process, participants reveal the types of information that they seek out, the order in which they retrieve information, and how the information is used or discarded. Participants were also asked to explain the meaning of certain items of information. This technique provided a rich insight into how participants attached meaning to various aspects of driving, and how they incorporated these meanings into their decision-making.

Detailed, verbatim notes were taken during the interviews. Initially, 10 of the interviews were audio recorded to check for accuracy of the note taking. Since the notes were found to be accurate, and since the audio recordings contained long periods of silence while the participants completed some of the tasks, further recordings were not undertaken.

Content analysis (Cavanagh, 1997) was used to analyze the verbal descriptions in a systematic and objective way. Content analysis is a research method for making replicable and valid inferences from data to their context (Kripendorff, 1980). The aim is to attain a condensed and broad description of the concepts, and the outcome of the analysis is categories describing the concepts. In the current study, inductive content analysis was used, wherein the categories were derived from the data . These categories were used to build a conceptual system of driving decision-making.

6.2.2. Other Qualitative Tasks

Participants completed two prioritizing tasks: 1) information preferences task, and 2) family statement influence task.

Information Preferences Task

To reveal the types of information that participants evaluate as important in making driving decisions, they were first asked to recall what information they would typically use if they were faced with a decision about going shopping. They were encouraged to describe the order in which they would use this information, and why it was important. Their responses were recorded. Participants were then given a set of 35 small cards on which were printed common types of information associated with driving decisions. The items were obtained through a review of the literature on older drivers and transportation decisions. In particular, the literature was reviewed to identify common reasons for travel, preferences for car use over other forms of transportation, reasons to reduce or stop driving, and contribution of factors in older driver crashes.

Participants were asked to review the items and to select only those that they would consciously think about when making a decision of whether to drive somewhere, to use an alternative method, or to not go at all. They were instructed to select items that would be top-of-mind and relevant in the present, rather than items that they might think about in future (e.g., if their vision declined). After they had selected the key items, they were asked to place them in order of importance on a scale; information items that they

usually considered together could be placed beside each other on the scale (e.g., time of day and traffic).

The items were reviewed with the researcher to ensure they met the criteria and the final solution was photographed. Results were analyzed by type of information selected, and compared across groups (gender, habit strength).

Family Statement Influence Task

Participants were first asked to recall comments made by others about their driving. They were encouraged to talk about what these statements meant to them, and how they responded. Their responses were recorded. Participants were then given statements written on small cards, and they were asked to complete a rating task by arranging the statements on a 4-point visual analog scale from “No Influence” to “A Lot of Influence”. Participants were instructed,

> *“Here are some statements that people sometimes say to each other about driving. Your [nominated person] may or may not have said some of these to you in the past. Please consider that **if** your [nominated person] said these statements to you, would they have a lot of influence on you, a little influence on you, or would you ignore them? Please arrange these statements on this scale according to how much influence you think they would have on you **if** your [nominated person] said them to you.”*

Four groups of statements (Appendix I) were presented in random order. Each group contained 12 statements designed to address one of four themes representing the intentions of the nominated person:

a) Support the elder to **continue** driving
b) Encourage the elder to **modify** their driving
c) **Discourage** the elder from driving
d) Get the elder to **stop** driving

Statements were developed from a review of the literature on older driver self-regulation and cessation, especially literature that included family involvement. Online resources aimed at supporting families in talking with an older driver were also considered.

After the participant had arranged a group of statements on the scale, it was photographed. They were then asked to talk about what the statements meant to them, why they thought the nominated person would say these things, how they would react, and why they had arranged the statements in that order.

After each group of statements had been arranged on the scale, participants were asked to select two statements from the “A lot of influence” end of the scale that they thought would have the greatest influence on them. This produced a maximum eight statements per participant, but less for individuals who had rated all of the cards in a group as having little influence. Participants were then asked to sort these “greatest influence” statements on the visual analog scale.

Participant responses were recorded and later transcribed alongside the photographs. Results were tabulated by high influence/little influence and compared across groups.

6.3. Quantitative Methods and Analysis

Quantitative analyses employed in this research were used in an exploratory manner and included a card sorting task and a stated preference scenario choice task. Analysis of these methods involved mapping techniques (multidimensional scaling and cluster analysis, respectfully) designed to reveal patterns in data rather than to test hypotheses using statistical probabilities. These techniques were appropriate for this research that focused on categorical data wherein parametric analysis is not suitable.

Fisher’s Exact Chi-square tests were used for categorical analysis.

6.3.1. Card Sorting

This task was used to gain a better understanding of how elders think about their driving environment, especially what are the main components that exert pressure on the individual while driving. This method revealed underlying constructs that may be used to evaluate their role within the driving community. It was hoped that by revealing

participants' attitudes towards driving, we would have a better idea of the role that context plays in driving decisions. Since these concepts are generally difficult to verbalize, a card sorting technique was used.

Card sorting is a participatory, user-centered technique used to elucidate the attitudes, values, desires and/or behaviors of participants as they relate to the domain under study. Card sorts deliver insight into how participants make sense of the domain or subject under consideration. This method can "provide insight into users" mental models, illuminating the way that they often tacitly group, sort and label tasks and content within their own heads." (Rosenfeld & Moreville, 2002).

Card sorting was an appropriate technique for this research. Because the meaning of driving is a latent variable, it is necessary to identify the indicators that form a composed measure of such a concept. Exploratory factor analysis (EFA) is a statistical technique commonly used to determine the strongest indicators; however, EFA requires large sample sizes. In this research, the sample population was small, making it impossible to extract enough data for EFA. Card sort techniques produce similar results but require smaller samples. In fact, as few as 25-30 participants will likely yield results similar to those of several hundred, provided these participants are representative of the target group and are familiar with the domain being questioned (Wood & Wood, 2008).

There are several varieties of card sorting techniques (Rugg & McGeorge, 1997). In this research, a free-sort technique was used wherein participants were not restricted in the number of groups or piles they generated. This technique was considered most appropriate to revealing the unique classification systems of each individual. Free card sorting is considered more easily understood, interesting and natural than other techniques that require the participant to constrain their thoughts to a predetermined structure (Whaley & Longoria, 2009).

Participants were given a stack of 50 pictures to sort into piles (see Figure 8,Figure 9, & Figure 10). To reduce bias, all photos were mounted on 4" x 5" index cards of identical size with the exception of one photo that could not be scaled accordingly. The cards contained photographs of driving situations and/or mature adults (see Section 7.2.3). The photos were chosen to represent three general topic areas related to driving, as identified

from the literature: driving environments, health, and social. Each card had a unique identifying number that was located on the back of the card so as not to bias the participants. During the study, no participant became aware of the photo numbers during the sorting task.

Before beginning the task, participants were given an example of a card sorting task using 8 photographs of furniture. The intent of the example was to ensure the participant understood the concept of sorting by criterion. The researcher demonstrated the concept of sorting the cards according to the criterion “colour”. The participant was then asked to demonstrate another criterion that could be used to sort the cards.

When the researcher was satisfied that the participant understood the concept of sorting by a criterion, the participant was asked to sort the cards according to, “your own driving and what these mean to you”. Consistent with free sort methods, participants were instructed to take their time, to create as many or as few piles as they wished, and to set aside any cards that they felt were irrelevant into a “miscellaneous” pile. The sorting task was performed once.

Participants were encouraged to think aloud as they sorted the piles of photos. After they had completed the card sort, they were asked to give a name to each pile; the name and card numbers were recorded. All participants were encouraged to explain what the sorted pile meant to their own driving and these statements were also recorded. This sometimes resulted in rich explanations but at other times only the name of the pile (e.g., “just happy people”) could be elicited. In instances when little detail was forthcoming, it was interpreted that the individual possesses primarily tacit knowledge of the concept (subjective insights & intuitions not easily formulated).

Multidimensional Scaling

Multidimensional scaling (MDS) was used to analyze the large volume of data obtained from the card sorting task. MDS is a statistical technique commonly used for the mapping of responses and perceptions of study participants. It uncovers underlying dimensions based on a series of similarity or distance judgments of subjects. In that sense, it may be thought of as a type of perceptual mapping in which the axes are the underlying

dimensions and the points are the opinions being compared. The distances separating the points reflect the subjective distances of objects, and MDS graphically shows how the objects cluster. MDS is mainly used to compare objects when the dimensions (the basis) of comparison are not known and which may differ from observable characteristics. This method is ideally suited for this study where the observable characteristics of the photos in the sorting task are known by the researcher, but the underlying value or interpretations by the subjects are not known.

The advantage of the MDS procedure is that it deals with each response as a categorical one, comparing the categories with each other. No order or similarity of meaning is assumed between the various categories. MDS does not require assumptions of linearity, metricity or normality, so in tasks such as free sorting of cards, it is preferred over factor analysis (Garson, 2012).

Results represent the sharing of an understanding of a concept. Of particular interest is to try to identify the type of conceptual system groups are using, i.e. the structure and content of elements.

In studies of conceptual systems there exist three general ways in which the data can be examined: 1) by considering differences between people; 2) by considering differences between the elements; and 3) by considering differences between the concepts and categories to which participants assign the elements (Canter, Brown & Groat, 1985). The analysis in this research focused on differences between elements and then between groups of people.

SPSS© version 23 ALSCAL was used in the analysis. Binary data were entered into a matrix indicating which cards the subject had placed together in a pile. The data were translated into Euclidean distances between variables. A model was produced by mapping each point.

6.3.2. Stated Preference Choice Scenarios

This task was used to explore decisions about driving that elders make in their day-to-day travel needs. Whereas some individuals may choose to drive under certain

conditions, others may decide to use alternate means of transportation, or to not travel at all. Directly observing in-time decisions may be the optimal method of studying decision-making; however, it was not a practical method for this research due to privacy, time involvement, and logistic demands. Instead, a stated preference task was used, based on hypothetical examples and examination of preferred responses.

Two main methodologies may be used in studying decisions: revealed preferences (RP) and stated preferences (SP). Revealed preferences examine actual decisions made in everyday life and are difficult to conduct because they depend on observing the subjects in real time. Alternately, subjects may be asked to recall decisions that have already been made. Although this gives information about choices, it is often difficult for people to accurately recall reasons and processes involved in the decision-making. This may be especially difficult for elders with poorer memories. To resolve this problem, imaginary scenarios are used in laboratory settings while participants “think aloud” through their decisions (vanSomren, Barnard & Sandburg, 1994).

Stated preference experiments involve asking people to choose between hypothetical choices, and are easier to administer because they do not rely on recalled information. Stated preference experiments can control for interactions between elements and allow for tight control over information and alternatives available to the individual, so are popular in experimental situations. However, success of stated preference experiments depends on the individual’s ability to imagine different scenarios. They may not accurately reflect actions, however they are useful for revealing underlying values assigned to different attributes of information. The combination of RP and SP reduces the problems inherent in each method (Sanko, 2001), but is difficult to attain for reasons outlined above.

Constructing SP experiments may be done in a manner that allows statistical analysis on large samples. Discrete Choice Experiments (DCE) is a quantitative methodology that has been widely used in SP experiments to study how people make decisions (Lancsar & Louviere, 2006), especially in the fields of marketing and transportation. DCE is based on stated preferences and was designed to establish the relative importance people attach to characteristics (attributes) in making a decision about

a particular choice of action (Ben-Akiva & Lerman, 1985). DCE studies have been used successfully in older populations, for example, to study decisions related to health care and to driving cessation (McNamara et al., 2013).

Discrete choice models specify the probability that an individual chooses an option among a set of alternatives. Paired alternatives are developed for various levels of different attributes of the topic or item being explored. By examining the choices, the relative weights the individual places on various attributes are revealed, along with the underlying preferences of the individual. This makes it suited for this study aimed at exploring the relative importance older drivers place on different types of information in making driving decisions. However, because this study is exploratory in nature, quantitative analysis on the small sample size is not possible. Nonetheless, this study was designed to followed the basic structure of DCE to reveal, in a qualitative way, the relative importance of different types of information used by study participants in making their decisions.

Following the general methods of DCE, key factors that were likely to be important to older people when making driving decisions were identified through a review of the literature. The Older Driver Decisions Components Framework, developed for this thesis, provided the underlying structure for selecting the key factors. In the Framework, three main categories of factors were identified and these were used as a basis for the study: *Motivators*, *Constraints*, and *Contextual Factors*. Within each category, several elements were selected (Table 1) and for each element, three distinct levels were developed: low, medium and high.

Table 1. Key factors, classifications and elements selected for discrete choice type scenarios

KEY FACTORS	CLASSIFICATIONS	ELEMENTS
MOTIVATORS	Perceived Need	Instrumental – medical
		Instrumental – ADL
		Social
	Alternatives	Taxi/bus
		Passenger
	Vehicle	Instrumental

KEY FACTORS	CLASSIFICATIONS	ELEMENTS
		Interpersonal-ego
CONSTRAINTS	Health	Physical – acute
		Physical – chronic
		Mental/emotional
	Environment	Weather
		Traffic
		Route
CONTEXTUAL FACTORS	Interpersonal	Family
		Doctor
	Skills & Abilities	Objective evidence
		Subjective appraisal

Six sets of scenarios were developed by combining the different elements and levels of elements. Each scenario was composed of a reason for the trip, and eight additional elements describing the circumstances. Although a full DCE experiment would require 512 scenarios ($8^3 = 512$), this was an exploratory qualitative study so only 12 scenarios were constructed.

Participants were presented with two scenarios at a time. These scenarios were presented on a single sheet of paper, printed in two columns labelled Scenario A and Scenario B. Each scenario had different combinations of attributes (Appendix H).

Participants were asked to read each scenario and decide whether they would drive in each. They were asked to think aloud as they considered each, and to explain the reasons for their decisions by citing the elements they used in making the decision. In cases when they had the same decision for both scenarios, they were asked to choose under which scenario they would be most likely to drive, and to explain the reason(s) for their choice.

Participants were reminded throughout the session to respond as if the circumstances in the scenarios were real and not to consider their current circumstances.

For example, they were asked to imagine their doctor was across town as described in the scenario, rather than to consider that in reality their doctor is only one block away.

Cluster Analysis

To help explore discernible groups with different decision-making patterns, cluster analysis (SPSS© version 23) was used. Cluster analysis is traditionally a descriptive data exploration technique used to divide a multivariate data set into “natural” clusters or groups. It is commonly used when there is a belief that the sample contains an unknown number of distinct sub-populations, but there is no a-priory definition of those sub-populations (PennState University, 2016). Cluster analysis was considered appropriate in this study to explore whether sub-populations of elders with different decision styles could be determined based on their stated preferences. Cluster analysis was used, therefore, to explore if any sub-populations might exist and if so, to define their characteristics. Since the decision scenarios created 2^{12} = 4096 possible combinations, a cluster analysis tool was used to aid in this analysis.

There are many different approaches to cluster analysis and it is common to compare results using different methods. However, the current study contains binary data yielding some methods inappropriate. SPSS©’s TwoStep method allows analysis of binary data. This method combines the advantages of different statistical methods by first identifying the groupings by running pre-clustering, followed by hierarchical cluster analysis. Another advantage of the TwoStep cluster method is that it automatically selects the number of clusters, whereas in other methods the number of clusters must be selected in advance. This makes it ideal for use in exploration of novel data, as in the current study, where the number of possible clusters is unknown.

The procedure begins with the construction of a Cluster Features (CF) Tree. The leaf nodes of the CF tree are then grouped using an agglomerative clustering algorithm. The agglomerative clustering can be used to produce a range of solutions. To determine which number of clusters is "best", each of these cluster solutions is compared using Schwarz’s Bayesian Criterion (BIC) or the Akaike Information Criterion (AIC) as the

clustering criterion. In this study, Bayesian (BIC) was used because it tends to choose fitted models that are more parsimonious than AIC (Cavanaugh, 2012). In order to handle categorical and continuous variables, the TwoStep Cluster Analysis procedure uses a likelihood distance measure that assumes that variables in the cluster model are independent. Each categorical variable is assumed to have a multinomial distribution. Empirical internal testing indicates that the procedure is fairly robust to violations of both the assumption of independence and the distributional assumptions (Michon, 2015).

Chapter 7. **RESULTS**

Results are presented in four sections:

- Sample Characteristics
- Driving Environment
- Driving Decisions
- Influence of Others' Comments

7.1. Sample Characteristics

7.1.1. Demographics

The study group was composed of a convenience sample of 20 male and 17 female community dwelling elders. All were Caucasian and proficient in the English language. Ages ranged from 70 years to 96 years. Mean age for men (80.6 years) was significantly older than for women (76.6 years; p =.04).

Participants in the study said they lived alone (n=24; 65%) or with a spouse (n=13; 35%) in private dwellings (condominium, apartment or home). However, during the interviews it was revealed that one shared a house with a friend and another lived in a suite in his daughter's house. A larger proportion of women (n=10; 70.0%) than men (n=14; 58.8%) lived alone, however the difference did not reach statistical significance. The sample contained five husband-wife couples.

Participants were well educated. Two-thirds (n=26) had at least a college diploma and 14% (n=5) reported having a graduate degree or equivalent. Two men and three women were working at least part time for payment. One-quarter of participants (n=7) had annual incomes of less than $50k and the same proportion reported incomes of greater than $100k. Women were more likely to have lower incomes and less likely to fall within the highest income bracket.

Table 2. Characteristics of Participants, by Gender

	Men	Women	*t*	*p*
N	20	17		
Age				
Mean (SD)	80.6 (6.4)	76.5 (4.8)	2.133	.040
Range	70-96	70-87		
MMSE	29.7 (.7)	29.9 (.3)	-1.297	.203
TUG (sec)				
Mean (SD)	9.9 (2.5)	8.9 (1.9)	1.312	.198
Range	6.1-13.7	6.9-13.4		
Number of Illnesses				
Mean (SD)	2.3 (1.2)	1.9 (1.4)	.736	.467
Range	0-5	0-5		
Live Alone	14 (70.0%)	10 (58.8%)		NS
Employed	2 (11.8%)	3 (15.0%)		NS
Income				
< $20k	2 (10.0%)	3 (17.6%)		
$20-$49k	2 (10.0%)	3 (17.6%)		
$50-$79k	6 (30.0%)	7 (41.2%)		
$80-$100k	2 (10.0%)	2 (11.8%)		
>$100k	8 (40.0%)	2 (11.8%)		
Education				
High school grad	1 (5.0%)	0		
Some college, technical	5 (25.0%)	5 (29.4%)		
College diploma, degree	8 (40.0%)	8 (47.1%)		
Some graduate education	2 (10.0%)	3 (17.6%)		
Graduate degree or higher	4 (20.0%)	1 (5.9%)		
Self-Rated Health				
Excellent	4 (20.0%)	2 (11.8%)		
Very Good	11 (55.0%)	11 (64.7%)		
Good	3 (15.0)	4 (23.5%)		
Fair	2 (10.0%)	0		
Health Compared to Others				
Much healthier	10 (50.0%)	5 (29.4%)		
A bit healthier	4 (20.0%)	9 (52.9%)		
About the same	5 (25.0%)	2 (11.8%)		
A bit less healthy	1 (5.0%)	1 (5.9%)		
Pain				
None	8 (40.0%)	9 (52.9%)		
Very mild	8 (40.0%)	6 (35.3%)		
Moderate	4 (20.0%)	2 (11.8%)		
Severe	0	0		

	Men	Women	*t*	*p*
Prescription Medications				
None	2 (10.0%)	5 (29.4%)		
1	2 (10.0%)	3 (17.6%)		
2	2 (10.0%)	3 (17.6%)		
3-5	12 (60.0%)	4 (23.5%)		
>5	2 (10.0%)	2 (11.8%)		
Not limited at all				
Lifting or carrying groceries	16 (80.0%)	10 (58.8%)		
Walking one block	17 (85.0%)	12 (70.6%)		
Climbing 3 or more flights of stairs	11 (55.0%)	10 (58.8%)		
Bending to pick up something from the	15 (75.0%)	15 (88.2%)		
floor	14 (70.0%)	6 (35.3%)		
Opening a jar of pickles	6 (30.0%)	7 (41.2%)		
Balancing on one foot for 15 seconds	17 (85.0%)	15 (88.2%)		
Driving a car				

7.1.2. MMSE

All participants completed the Mini Mental State Exam (MMSE; Folstein et al., 1975). Scores ranged from 28 to 30. Normative scores for adults age 70-85 and high school education are 28.2-26.9 (SD 2.0-1.8) (Bravo & Herbert, 1997), indicating the participants were representative of the normal population. Since MMSE scores above 24 indicate low likelihood of cognitive impairment (Lopez, Charter, Mostafi & Smith, 2005), it may be concluded that all participants in the study had normal cognitive function.

7.1.3. Timed Up and Go (TUG)

TUG (Timed Up and Go walking speed) test scores ranged from 6.1 seconds to 13.7 seconds. For community dwelling adults, a time of ≥13.5 seconds is at high risk for falling (Shumway-Cook, Brauer & Woollatt, 2000). In this research, only one man had a score above the cut-off value, i.e., 13.7 seconds. Normative scores for men and women aged 70-79 years are 7-11sec and 8-10sec, respectively; for ages 80-89 years the normative scores increase to 9-11sec and 9-12sec, respectively (Steffen, Hacker et al., 2002). In this study, six men and one woman scored slightly above the norm for their age

group indicating possible mobility challenges. Mean TUG scores for men (9.9 seconds) and women (8.9 seconds) were not statistically different.

7.1.4. Self-Reported Health

The majority of participants rated their health as very good (60%), and 16% rated it as excellent. Compared to others of similar age, 41% thought they were much healthier and 35% thought they were a bit healthier. Two participants thought their health was a bit worse than others their age. Among Canadians age 65 years and older, 39% rate their health as excellent or very good (StatsCan, 2015a).

Almost half (41%) of the participants in this study said they do not suffer from any pain and 38% said they have only mild pain. The most common areas of pain were shoulders/arms/hands and legs/feet. About three quarters of the participants reported they had no limitations in lifting groceries (70%), walking one block (78%), and bending to pick something up off the floor (81%). Half (57%) said they were not limited at all climbing 3 or more flights of stairs, or opening a jar of pickles (54%). However, only 35% of the participants said they were able to balance on one foot for 15 seconds. Among Canadians age 65 years and older, 17% of men and 24% of women report having pain that limits their daily activities (StatsCan, 2015b).

Almost half (43%) of the participants reported taking 3 to 5 prescription medications, and most (81%) reported 1-3 health conditions, most commonly arthritis (51% of participants), high blood pressure (43%), heart attack or heart problems (24%) and neuropathy (22%). Three-quarters (76%) of the participants in this study declared they always or often feel “full of pep and energy”. Most (92%) said they always or often feel “happy or optimistic”, but 6 said they sometimes or always feel “downhearted or blue”.

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7.1.5. Driving Characteristics

This sample of older drivers reported they learned to drive between the ages of 15 and 32 years, and 79% had learned to drive by the age of 19. Both men and women learned to drive at an early age.

Participants in the study said they drove 1-7 days per week (mean 5.3 days) and 1-20 hours per week (mean 9.41 hours). There was no difference between men and women in mean number of days driving (5.6 vs 4.8) or driving hours per week (11.1 vs 7.9). Half (51%) said they drive most or all of their trips alone.

Most (60% of men and 70% of women) said they drive “about the same speed” as others on the road, and approximately equal numbers said they drove “a little bit faster” or a “little bit slower”. No-one admitted driving either “much faster” or “much slower” than the flow of traffic.

Men were more likely than women to describe the quality of their driving as “good” (65% of men), whereas women were more likely to say it was “average” (41% of women). About 20% of both men and women rated their driving as “excellent”. Half of both men and women said they were “quite confident” in their driving. However, 40% of men but only 18% of women said they were “very confident”. Women were more likely to rate their confidence as “average” or “a little confident”.

The questionnaire asked how often the participants avoided certain driving situations. Eight women and 7 men (40%) reported never avoiding any of the driving situations presented in the questionnaire. The proportion of men versus women who avoided specific situations was similar, although slightly lower for women. The exception was for driving during rush hour, where almost double the proportion of women (82%) reported avoidance of rush hour compared to men (45%).

Two women and eight men reported having a minor bump or scrape within the past 6 months but no crashes were reported. Only one man reported a traffic violation.

Table 3. Driving Habits of Participants, by Gender

	Men	Women	*t*	*p*
N	20	17		
Start Driving Age				
Mean (SD)	17.1 (2.3)	18.7 (5.1)	-1.252	.219
Range	15-23	16-32		
Driving Days/wk				
Mean (SD)	5.8 (1.3)	4.76 (2.1)	1.931	.062
Range	3-7	1-7		
Driving Hours/wk				
Mean (SD)	11.1 (5.7)	7.9 (6.7)	1.581	.123
Range	2-20	1-20		
Driving Habit (SRHI)				
Mean (SD)	42.7 (6.8)	40.2 (10.1)	.883	.383
Range	29-54	22-55		
Trips Drive Alone				
0- ¼	1 (5.0%)	2 (11.8%)		
¼- ½	6 (30.0%)	1 (5.9%)		
½- ¾	6 (30.0%)	2 (11.8%)		
¾-all	7 (35.0%)	12 (70.6%)		
Drive in traffic				
A bit faster	4 (20.0%)	3 (17.6%)		
The same speed	12 (60.0%)	12 (70.6%)		
A bit slower	4 (20.0%)	2 (11.8%)		
Self-Rated Driving				
Average	3 (15.0%)	7 (41.2%)		
Good	13 (65.0%)	6 (35.3%)		
Excellent	4 (20.0%)	4 (23.5%)		
Driving Confidence				
A little non-confident	1 (5.0%)	2 (11.8%)		
Average	1 (5.0%)	3 (17.6%)		
Quite confident	10 (50.0%)	9 (52.9%)		
Very confident	8 (40.0%)	3 (17.6%)		
Never Avoid				
Driving in dark	14 (70.0%)	11 (64.7%)		
Backing	16 (80.0%)	12 (75.0%)		
Left turns	19 (95.0%)	13 (76.5%)		
On highways	19 (95.0%)	14 (82.4%)		
In rush hour	9 (45.0%)	14 (82.4%)		
Parallel parking	17 (85.0%)	13 (76.5%)		
In bad weather	13 (65.0%)	11 (64.7%)		
Use Transit				

	Men	Women	*t*	*p*
Never	5 (25.0%)	1 (5.9%)		
Occasionally	13 (65.0%)	10 (58.8%)		
Half or more of trips	2 (10.0%)	6 (35.3%)		

7.1.6. SRHI (Self-Reported Habit Index)

It is reasonable to expect that individuals that have high habit for driving would tend to drive more than those with low habit strength. The SRHI habit strength scores were compared with self-reported driving frequency. As seen in Figure 5, increases in SRHI scores were associated with higher number of driving hours per week.

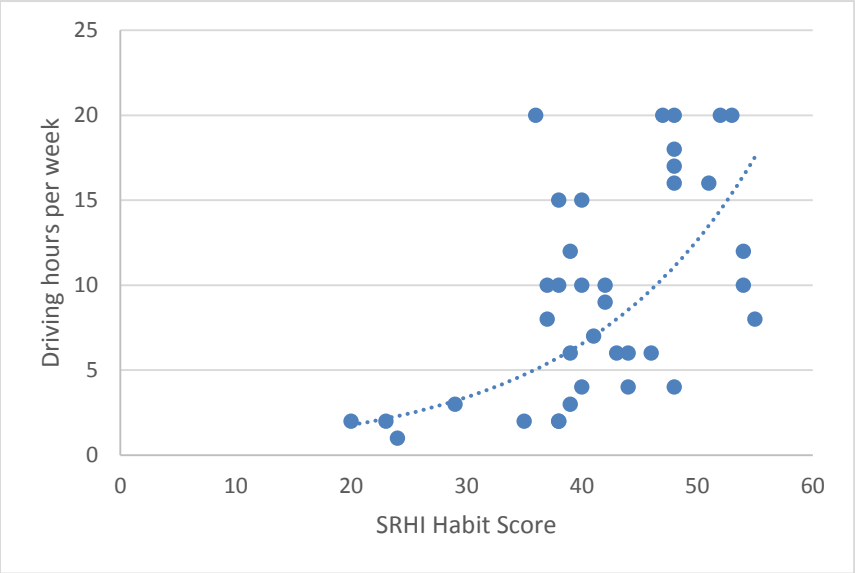


Figure 5. Association between SRHI habit scores and number of driving days per week [exponential trendline]

SRHI habit strength for driving scores ranged from 20 to 55 (mean 41.2). Mean scores for men (42.7) were not different than for women (40.2).

Based on the suggestions by Cohen (1983), three groups for habit strength were created using one standard deviation from mean score for habit strength. However, this resulted in rather large group size differences, with most participants being classified as Medium Habit. Since unequal sample sizes across groups lead to decreased power to

detect parameter differences, especially for small samples (Alexander & DeShon, 1994), groups were differentiated based on half a standard deviation from mean score for habit strength, as suggested by deBruijn et al. (2007).

Using this method, low habit strength was defined as lower than or equal to a score of 37 (n=6); medium habit strength was defined as a score of 37-46 (n=18); and high habit strength was defined as a score equal to or higher than 47 (n=13).

7.1.7. Modified Interpersonal Relationship Scale – Abbreviated format (MIRS-A)

Scores for the MIRS-A ranged from 72 to 131 (mean 111.3). Items positively worded were reverse- coded prior to analysis, resulting in high scores corresponding to high relationship quality (Guerney, 1977).

Mean scores, presented in Table 3, show similar results for relatives and non-relatives with the exception of one sister-in-law and one ex-wife who scored lower. Mean relationship scores with daughters were highest, although there were no statistically significant differences found across any groups.

Table 4. Number of family/friends chosen and mean MIRS-A scores

	Men	Women	Mean MIRS-A score
Wife	**15**	**--**	**111**
Husband	**--**	**7**	**116**
Son	**1**	**1**	**106**
Grandson		**1**	**102**
Daughter	**2**	**2**	**123**
Sister-in-law		**1**	**72**
Friend	**2**	**4**	**117**
Ex-Wife	**1**	**--**	**78**

7.2. The Driving Environment

One of the most important characteristics of a decision is the context in which a decision takes place. Context includes the set of values, preferences, and constraints that surround the question. It is composed of items that may be relevant to the central issue, and that may need to be reflected in thinking about the issue. For driving, the context may be considered as made up of a physical space (roadways, vehicles, weather, etc.), a social space wherein drivers interact with each other, and a psychological space of the driver's own beliefs and actions. Since the context of driving is central to the issue of driving decisions, this research included an exploration into how elders think about driving and the environment in which they operate a vehicle.

7.2.1. Interviews

When asked, "What does driving mean to you?" by far the most common response, given by 18 (48%) of participants, highlighted the functional utility of a vehicle. Statements such as, *"it's a means to get from A to B"* and *"a way to get somewhere"* were common first responses and reflect the use of a vehicle primarily to get to a particular destination. Driving was also associated with transportation of goods, especially among women, in statements such as *"I can go to Walmart to load up, to get groceries"*. Two men described driving as *"a necessity"*, meaning it was a tool they needed to accomplish a variety of tasks. Top of mind, participants in the study considered driving as a tool for transportation of self and goods.

When probed, some participants revealed deeper meanings. Driving was identified as a lifestyle, or as a tool to support lifestyle, by three participants: *"it allows me to lead the lifestyle I want"*, *"if I didn't drive I could not do some things anymore"*, and *"it gets me out"*. "Freedom" and "independence" was mentioned by two men and three women, and one participant stated, *"The alternative is confinement"*. These comments demonstrate

that the meaning of driving goes beyond simply an activity. It represents a means to be the way an individual wants to be, to live a life according to desires, and to fulfill personal needs.

A strong sense of identity to driving was expressed by a few individuals with the statements, *"driving is just natural"*, *"it's something that I do"*, and *"it's a part of my life"*. Two individuals referred to driving as a habit, but one woman said, *"I wouldn't give it a second thought not to drive".* One woman was unique in the study group in expressing her love of the challenge of driving, especially in bad weather, heavy traffic, and new roadways. She declared she loved driving so much, *"I should have been a truck driver"*. Another woman described how the meaning of driving had changed for her: *"It was so much a part of my life. Now I don't need it as much anymore."* These comments indicate driving is currently considered a part of self-identity by only a minority of drivers in this study. However, it is possible that this may have changed from younger years where driving and self-identity were more tightly connected.

Only one individual (a woman) mentioned the responsibility of driving, declaring it a burden. Two women in the study talked about how driving represented social norms. The first described how driving was equated with a sense of power for her, allowing her to "measure up". The second woman described how she and her friends judged each other on whether they were still driving or not:

> *We all drive to prove to each other we can still drive. Aren't we wonderful? It means your eyesight is OK, you still have the physical ability. It is absolute vanity, prestige. It's competition…Driving signals that you can cope, stand the pressures of driving… An old lady in a taxi signals aging! Looking young is the most important. If you're old & frail you take a taxi, but not until then.*

The participants in this study did not talk outwardly about driving as an emotion. Most often, they expressed muted feelings. Only three individuals spontaneously said they *"love driving".* Others needed prompting and when asked, the majority said they "like it but don't love it", or "don't mind it". Three participants described driving as "pleasurable".

These comments about the meaning of driving suggest a dichotomy. Driving, appears to carry different meanings depending on which aspect of driving is being considered. The act of driving, itself, is often seen as a task that carries little emotional value, although for some the act of driving is valued as pleasurable or fun. For many, it is seen as a means-to-an-end type of activity that may be endured rather than enjoyed. However, the products of driving, such as freedom, independence, and choice enabling, are highly valued. This may be similar to, for example, house cleaning where the act of cleaning a house, for some, is not considered particularly engaging, but the benefits of living in a clean house are highly valued.

Summary

Amongst this group of older drivers, it appeared that the task of driving was considered primarily a tool of transportation and social interaction rather than as an emotional experience. This description of driving as “a way to get from A to B” has been reported in other studies as a common response when individuals are directly asked about the meaning of driving. However, if people are asked more indirectly to evaluate the attractiveness of car use, the affective and emotional factors seem to play a more significant role (Steg & Tertoolen, 1999). Other studies have found that the meaning of driving includes aspects of self-identity (Donforino et al., 2009; Pachana, Jetten, Gustafsson & Liddle, 2016), independence, a sense of enjoyment, and connectedness (Donforino et al., 2009; Hassan, King & Watt, 2015). In this study, only a few drivers equated driving with independence, enjoyment, and an outward symbol of physical and mental health associated with functional (but perhaps not chronological) age.

In response to the question about the meaning of driving, for most, driving was not overtly considered a part of the participants’ self-identity. However, this may have been a result of the directness of the question. There were some indications that driving was related to participants’ self-identity, but there were also suggestions that for some, self-identity as a driver may have decreased over the life course. This is in contrast to some other studies that have highlighted the importance elders, especially men, place on driving as a symbol of their self-worth (Eisenhandler, 1990; Fonda, Wallace & Herzog, 2001).

The meaning of driving may have implications for transportation decisions. If driving is seen strictly as a tool to reach a specific goal, and if the value of driving is primarily in what it delivers, then individuals may be more open to considering alternatives to reaching that goal, for example, public transit, taxis, walking, cycling, or rides from others. Decisions about transport, then, would become more complex in evaluating more options and the related information. On the other hand, if driving is strongly connected to self-identity, individuals may be much less open to considering alternatives to driving and transport decisions would be less complex, involving fewer deliberations or choices. In other words, for those who attach strong meaning to driving, transportation may be represented by fewer choices and stronger habits for driving. This issue is further investigated in Section 7.3

7.2.2. Content Analysis of Card Sort Piles

To further explore how the participants experienced their driving context, they were asked to examine photos depicting various aspects of the driving environment and drivers, and to sort them into piles according to how they perceived similar characteristics. Allowing individuals to freely determine characteristics by which to sort cards reveals aspects of how they interpret those items within a context.

The free card sort produced 283 piles of cards with associated descriptions. The number of piles per individual ranged from 4 to 17 (mean 10). There was no difference between men and women for mean number of sorting piles; individuals classed as Low and High habit strength produced a mean of nine piles while those categorized as Medium habit strength produce on average, 10 piles. Number of cards per pile ranged from 1 to 27 but most piles contained 7 cards or fewer.

Using content analysis, 17 categories of piles were identified from the data and given names. Care was taken to understand the key meanings of the piles and to assign them to the appropriate category. To reduce the likelihood of researcher bias in categorizing the statements, the participants' statements were given to two independent raters, one with a MA degree in counselling psychology and the other with an engineering degree. The raters were asked to allocate each statement into one of the 17 categories,

or to form new categories where he thought they were required. Any disputed categories were then subject to negotiation and a solution agreed upon between the researcher and the rater. Initial agreement was 83% and 87%, respectively, but increased to 91% and 93% after resolving conflicts. No new categories were created.

For men, 17 categories were identified but for women only 16 categories emerged (Table 2). A separate category, labelled "Need for Caution", was found for men but not women. Several men made statements such as *"be extra careful"*, "take caution, be on the lookout" and "use caution, be alert". Men also specifically mentioned the need to be careful of pedestrians whereas women did not.

Although the category names were similar for men and women, there were some subtle differences in meanings between the genders. Both men and women recognized country roads and highways as "*easy driving"*, but men described them as "*fun"*, a term not found in the women's descriptions. Women but not men identified photos of older drivers with the words "*independence"* and "*freedom"*. Women most frequently described city driving as "*busy"* and "*challenging"* whereas men talked about either their "*frustration"* with traffic or their "*comfort*" with driving in traffic.

Almost all participants reacted in a strongly negative way to the photo of a driver using a cell phone. However, women were much more likely to comment about driving distractions in general, including cell phones, looking at things outside the vehicle, thinking about things other than driving, and health problems as causes of distraction. Women but not men cited distractions as a cause of crashes.

In describing photos depicting minor crashes, some men (but not women) expressed emotional reactions such as *embarrassing*, *stupid*, and *stressful*, while other men focused on the other driver (e.g., *problem people*) as the cause of a crash. In fact, men talked more about others they considered to be bad drivers, described as exhibiting *"poor driving skills"*, *"doing wrong things"*, and displaying *"dangerous driving"* behaviour. Both men and women labelled some people in the photos as "*these shouldn't be driving*", mainly because of poor health that affects, for example, reflexes and concentration.

In photos depicting health related items, only men mentioned that their health did not affect their driving. Some women (but no men) said they foresee future health declines. Both men and women stated exercise is good for you; one man and 2 women specifically stated that exercise and good health improves driving.

Table 5. Card Sort Categories and Sample Statements

CATEGORY	MEN		WOMEN	
	n		*n*	
Easy driving	13	Perfectly comfortable with these. The lure of the open road – quite relaxing.	10	Calming, pleasant, hardly anyone on the road, open, I like driving in these, it's easy.
Normal driving	6	A day in the life of driving, what you normally cope with.	9	General driving, what you usually see.
City driving	4	Gridlock, frustration. Traffic, paying attention, new areas, anticipate others – very comfortable in traffic.	10	Busy, intersections, visibility is poor, not pleasant.
Weather	4	Bad weather – stupid to speed, be more aware of hazards.	7	Difficult driving, adverse conditions, I wouldn't think of driving
Distractions	7	No-Nos, distractions. Potential distractions, drivers not paying attention.	15	A lot of stuff is distracting – I couldn't drive with these in my face. Crashes – results of distraction
Signage	6	You look at the biggest sign first. More things take the brain time to absorb and decide, more dangerous. Confusing signs and situations, out of the ordinary – these are not hard for myself.	4	Wayfinding and confusing challenges, especially if you don't know where you are.
Parking	12	No problem with these. Parking is not easy for me but I do it – I won't use a tight space.	6	I'm an absolute zinger at parallel parking!
Things to avoid	14	Don't like it but I'll do it.	8	Never drive in snow – don't take risks.
Caution needed	14	Use more caution, be more aware, especially pedestrians.	–	
Crashes	11	Embarrassing situations. Uh oh's – problem people not being careful enough, not watching.	11	Crashes, just so easy to happen in malls, parking lots, so much coming and going all the time.
Vehicle equipment	13	Mechanical things. Good idea testing things.	6	GPS, the best invention man ever came up with. The technical side of driving.

CATEGORY		MEN		WOMEN
Speeding & violations	5	Traffic enforcement – I favour it strongly.	4	What I don't like about driving: speed, crashes.
Bad drivers	10	People doing wrong things, influencing safety	3	What people do to others – leads to road rage, dangerous.
Shouldn't be driving	10	These people shouldn't be driving, I would think their reflexes are not all that great.	9	Shouldn't be driving – medical issues can interfere with concentration and cause distraction.
Health	15	Illness and medicines have never compromised my driving. Reminds me that others have failings like me.	15	If you want to keep driving, get medical checks, take care medications don't have bad effects. People who are having trouble – I might be like this in 10 years.
People	31	The joy of driving & people enjoying it. Good humour, a good way to be while driving. Recreation, nothing to do with driving.	26	Older people like myself, enjoying themselves – enjoyment of driving is a positive thing in my life. Independence, freedom, and what driving means to me. Get out and about – have to drive to do this.
Reasons to drive	6	Daily use for driving.	4	Everyday errands.

Summary

The card sorting task presented participants with photos depicting the physical driving environment as well as photos that indicated psychosocial aspects of driving and health. How individuals sorted these photos helped to reveal how they interpret these constructs within the understanding of their own driving experiences.

Qualitative results of this card sorting task showed some differences between how men and women in this study interpret their driving experiences. The women were more conscious of the busyness of city driving environments and considered road sign clutter, complicated pavement markings, pedestrians, traffic, and drivers using cell phones as distractions that contribute to crashes. They spoke openly about avoiding these situations. The men identified challenging situations but were more likely to say they would not avoid

them. They seemed to be expressing that they manage these aspects of driving by being more cautious, including driving slower and paying more attention. The men were more conscious of other drivers whom they considered “bad drivers’ doing “stupid things” and creating the crashes. Hence, although the women seemed to be saying that they might be involved in a crash if they drove in circumstances that were too distracting, the men seemed to imply that they could manage a hectic environment, but that others, driving badly, would be the cause of a crash. Men also expressed more emotion about crashes than women, saying that they would feel embarrassed, whereas women tended to take the position that sometimes crashes just happen as a result of the driving environment.

7.2.3. Multidimensional Scaling

From the card sorting task, a large volume of complex data was obtained that could not practically be analyzed for groups or patterns. To understand the underlying dimensions by which participants sorted the photos, a statistical technique was used to graphically show how the photographs clustered. SPSS© version 23 was used in the multidimensional scaling data analysis (ALSCAL, Alternating Least Squares Scaling). ALSCAL permits up to six dimensions, although interpretation of more than three dimensions is very challenging.

For multidimensional scaling models, the best known fit measure is the stress statistic. The stress statistic measures the difference between interpoint distances and the corresponding actual input distance. The stress statistic equals 0.0 if the fit is perfect. It is generally accepted that stress $\leq$ 0.1 is considered an excellent fit, and stress $\geq$ 0.15 is unacceptable, although in their original paper Kruskal and Wish (1978) categorized stress levels above 0.2 as poor. A high stress statistic may reflect measurement error but may also reflect having too few dimensions.

In this study the model stress statistic for the maximum 6 dimensions was 0.06 indicating excellent fit. To test the optimum number of dimensions, a scree plot was created by plotting the S-stress statistic for each dimension. An “elbow” in the plot indicates the optimum number of dimensions: increasing the number of dimensions (to the right of the elbow) shows there is little further reduction in the stress of the model, thus

indicating additional dimensions do not improve the model fit. The scree plot indicated a 2-dimension solution was the most efficient (Figure 6). For the 2-dimensional model the stress statistic was 0.145 indicating a marginally good fit.

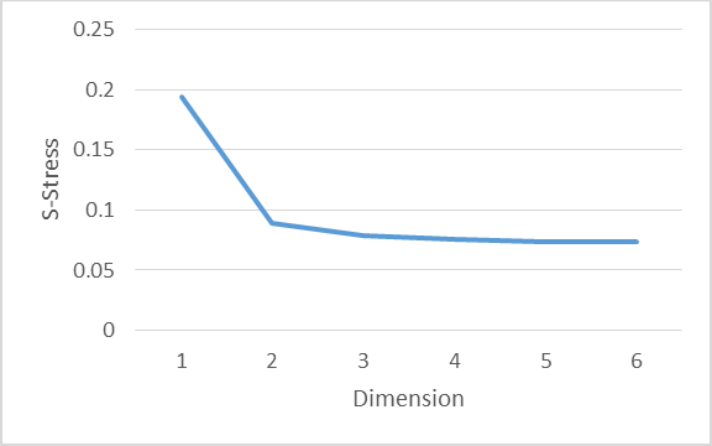


Figure 6. Scree plot illustrating optimum number of dimensions

Another measure of model fit is R-squared (R^2), with $R^2 \geq 0.6$ considered acceptable fit (Meyer et al., 2005). For a 2-dimension solution the $R^2 = .907$ in this study indicates acceptable model fit.

Two-Dimension Solution

Examination of the 2-dimension solution revealed a 3-factor structure arranged in a triangle around the plot (Figure 7). The three main factors contain elements dealing with: roadways; vehicles and crashes; and people. These indicate qualitative differences exist between older drivers' understandings of: the driving environment; crashes; and people who drive (Table 6).

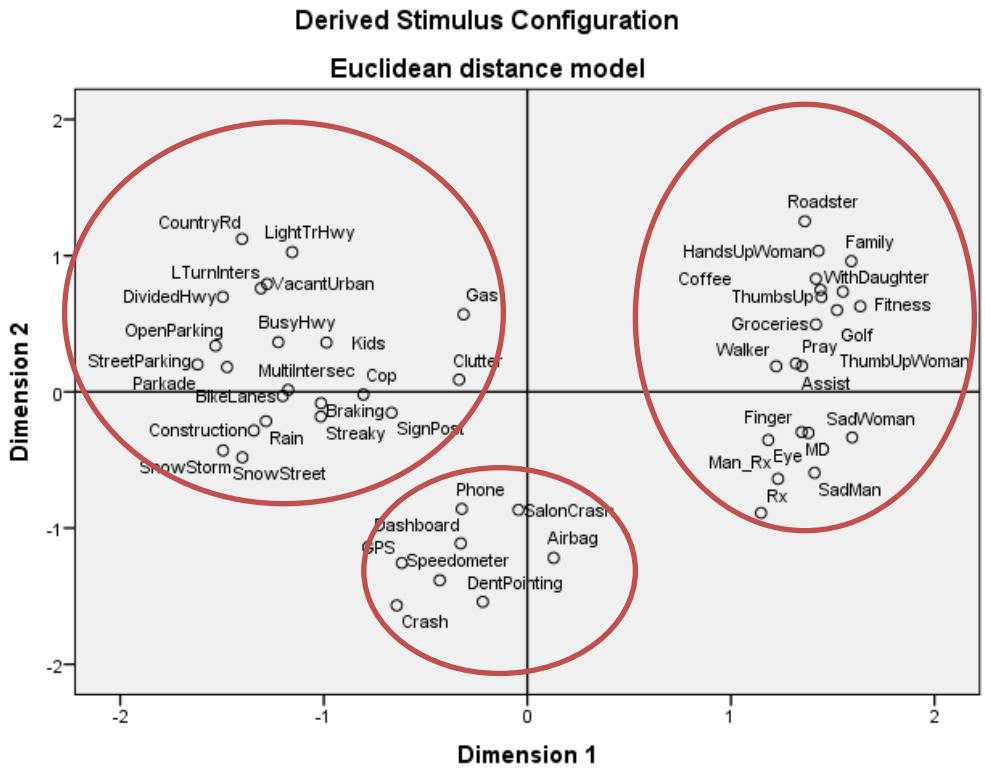


Figure 7. Two-Dimension Solution

Examination of the dimensions suggest the vertical axis represents **high to low driving difficulty** (valuated as risk). In the *Driving Environment* cluster (Figure 8), inclement weather, heavy traffic and parking are located lower on the scale and are generally associated with higher risk or more difficulty than open roadways which are located at the top. The location of left turns towards 'Lturninters' (left turn intersection) at the top of the scale is reflective of the photo which depicted a protected turn lane, likely interpreted as lower risk. In the *People Who Drive* cluster (Figure 9), medical conditions are located lower on the graph than happy drivers, suggesting the former present higher risk or more difficulty. The *Crashes* cluster itself (Figure 10) is located lowest on the graph suggesting higher risk, and within that cluster the photos of crashes are at the bottom. Presence of the photo 'salonCrash' higher than the other crashes likely reflects the fact that some individuals mistook it for parking.

The horizontal axis appears to represent a **sense of control**, wherein elders consider they have low control over the *Driving Environment*, more sense of control over

crash risk by being more alert and avoiding distractions, and higher sense of control over their own health, mood and lifestyle. The fact that *Crashes* cluster is in the middle indicates that the participants consider they have less control over other drivers than over themselves.

Table 6. Composition of Factors

Driving Environment	People Who Drive	Crashes
Country roads	Happy drivers	Cell phones
Highways	Angry drivers	Dashboard gadgets
Urban roadways	Social gatherings	Crashes
Intersections	Physical activity	Speeding
Signage	Physical health	Airbags
Weather	Mental health	
Parking	Medical practitioners	
Construction	Shopping	
Traffic	Family	
Speed enforcement		
Pedestrians		
Gas		

Figure 8. MDS Cluster 1: Driving Environment

Figure 9. MDS Cluster 2: People Who Drive

Figure 10. MDS Cluster 3: Crashes

Three-Dimension Solution

To improve the fit of the model, a third dimension was added. A test of a 3-dimensional solution produced a stress statistic of 0.118 and an R^2 of 0.922, both indicating improvements in model fit over the 2-dimensional solution. The 3-dimension solution is presented in Figure 11.

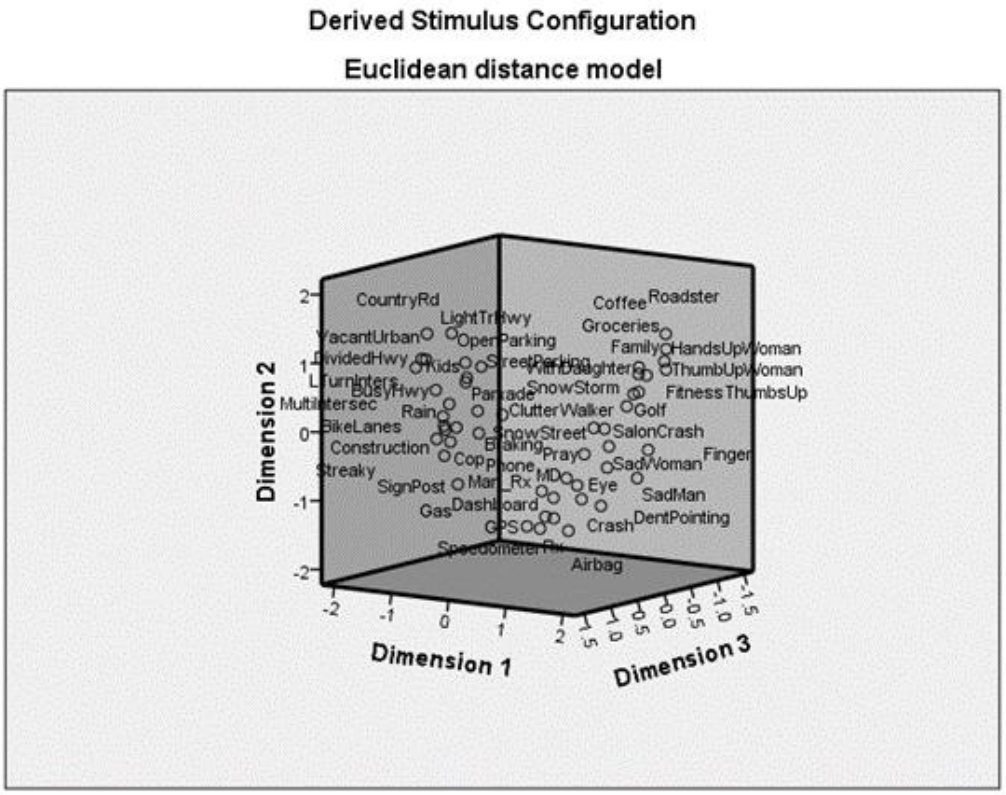


Figure 11. Three-Dimension Solution

Interpretation of Dimension 3 is more difficult. Examination of the data (stimulus coordinates) suggest it may represent the **amount of attention or vigilance needed** with the positive end of the scale requiring more vigilance. For the *Driving Environment* cluster, the elements at the negative end of the scale included parking and stopped vehicles while those at the positive end included a snow storm, construction zone, heavy rain, pedestrians and speed surveillance. For the *People Who Drive* cluster the positive end of the scale depicted poorer health. Almost all of the elements in the *Crash Risk* cluster, with the exception of the cell phone photo and the cluttered road sign photo, were mapped to

the negative (low vigilance) end of the scale. This seems contradictory since low vigilance can result in crashes. An explanation is that the crashes in the photos have already occurred and so do not reflect the immediate need for vigilance. If this is the case, it further suggests that the dimension may have a temporal component in the sense that participants were relating to the photos as if they were occurring at that time, and little vigilance would be needed after a crash had occurred. The fact that two other photos in this cluster, containing a cell phone and cluttered road signs, mapped into the positive (more vigilance) end of the scale and support this explanation.

Summary

Multidimensional Scaling was successful as an exploratory tool to reveal possible underlying constructs about the meaning of driving for this sample of older drivers. Three main constructs emerged indicating the participants think of driving in terms of: 1) the driving environment, 2) crashes, and 3) people who drive. These constructs are viewed as distinct aspects of their driving experience, and interact with the older driver.

The three-dimensional solution obtained from multidimensional scaling also revealed ranges against which elders measure the constructs. The first measurement dimension involved the perceived difficulty of the driving experience, interpreted as amount of *risk* inherent in driving. This was reflected in the variable mapping of simple versus complex roadways, good versus bad weather, and good versus poor health. The second dimension involved sense of *control*, ranging from low control over the environment to higher control over causing a crash and personal health. Finally, the third dimension may be interpreted as amount of attention or *vigilance* needed, possibly including a temporal component, where more attention is needed in hazardous conditions and less needed when the vehicle is stopped.

Based on these results, a model of Driving Experience is proposed (Figure 12). To my knowledge, no other user-oriented models of driving experience have been published, although other models have been developed for different driving related topics. For example, a model by Glasser and colleagues describes three main constructs of the

driving task as an interaction between environment, driver, and vehicle (Glaser, Rakotonirainy, Gruyer, & Nouveliere, 2007), however, this model was developed from the perspective of road safety experts rather than from the drivers, themselves.

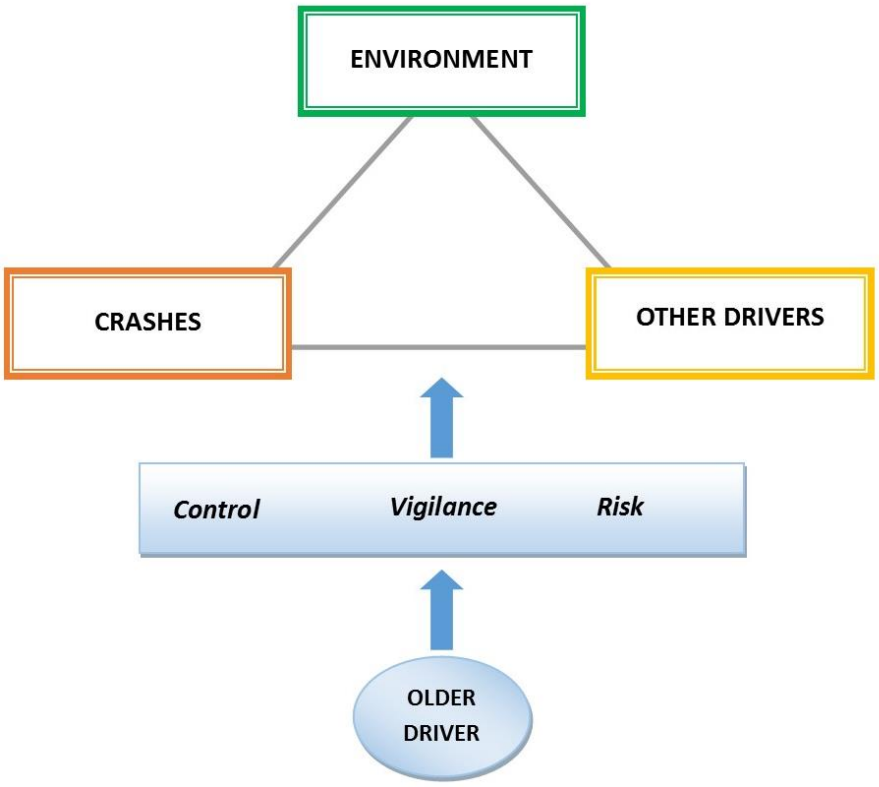


Figure 12. Proposed Model of Driving Experience for Older Drivers

This proposed model was supported by qualitative interviews during the card sorting task, in which main categories of discussion centered around driving conditions, other drivers, and causes of crashes. Furthermore, gender differences were revealed for the relative strength afforded each construct: the women appeared to be more cognisant of the driving environment whereas men appeared to be more contemplative of other drivers.

Results of this analysis has important implications for exploring the driving decisions of older people, in general, and subgroup differences in particular (i.e., gender). First, it indicates that when elders approach decisions about driving they may consider three distinct domains in their evaluations: the physical driving environment, crashes, and

other drivers on the road. The fact that there is no overlap between these categories in the mapping suggests that each is evaluated independently in making decisions. It is also possible that individuals place different emphasis on each of the three constructs in making their decisions.

7.3. Driving Decisions

Three techniques were used to explore how elders make decisions about their driving. An interview format allowed participants an opportunity to freely explain how they make decisions. A card sorting (Information Preferences) task allowed participants to select the type of information they use in decision-making. Finally, participants completed a Stated Preferences choice experiment.

During all tasks, participants were encouraged to talk about their decision-making, especially about the types and amount of information they used in formulating their choices.

7.3.1. Personal Interviews

When asked how they made decisions about whether or not they would drive to a destination, participants generally had one of two immediate responses. Some said, *"I'd just drive"*, suggesting an automatic or habitual decision process. They declared there was really no choice of whether or not to drive, or that there was never a reason not to drive. Others said, "it would depend on the circumstances". Circumstances included a variety of items such as the distance, location (especially traveling downtown or over bridges), reason for the trip, companions, and alcohol consumption. The following presents a summary of participants' comments on those items.

Distance

Many participants said if their destination was fairly close they would walk. The walkable distances ranged from 2 blocks to 1 mile. Some participants had moved within the past few years to "downsize" their living accommodations and reduce homeowner workload, and to be closer to friends and activities. For a few, the move was made in

recognition that in the long term they would be unlikely to continue driving and would need to be closer to services, including public transportation.

Although many respondents lived relatively close to services, walking was cited as a way to maintain physical fitness rather than as an avoidance of driving. Only one participant said he walks to avoid driving because he lacked confidence to drive. Another explained how she walks or takes transit to avoid the environmental impact of driving a car in the city, although she drives long trips for pleasure outside of the city. Walking through neighbourhoods was also seen as a pleasant way to travel in most cases, but if the environment was not conducive to walking then driving was usually the alternative. One woman said she that although she walked and hiked for pleasure, she would not walk to the store because it would include travelling along a busy route with traffic, noise, and dust. Three men said they did not take transit because they would have to walk and stand to wait for a bus on a busy road.

Location and Transit

All of the participants lived in urban areas and most were within a few blocks of transit. Several said that if they were going to downtown Vancouver, for example for theatre or shopping, they would take transit. The hassle and cost of parking in the downtown core was the most commonly cited reason. For these people transit was considered quicker and easier, avoiding traffic congestion on bridges and downtown streets. A few mentioned pedestrians and cyclists created a need for extra vigilance when driving downtown, and taking transit made the trip more relaxing. One woman described how she likes to take a bus downtown so she can be with other people for the long journey, compared to driving alone.

The general consensus was that taking a bus for trips of less than an hour was acceptable, but in cases where a change of buses was needed, participants preferred to drive. Several said they would take the Skytrain but not a bus, largely because it was considered more comfortable, easier to use, and faster.

Reasons for Driving

"It depends on what I'm going for," was a common response, especially among women. Shopping for groceries was frequently mentioned as a reason to drive, regardless of the distance. Several women said they would drive only a few blocks to the grocery store because they could not carry enough items walking. Others said it is too difficult to carry a lot of groceries by transit although they admitted they take transit downtown to purchase a few clothing items. Men did not mention driving for groceries as frequently, possibly because the married men in the study rely on their spouses to do the shopping. A few mentioned that their local store delivers groceries but none volunteered that they use the service. However, a few mentioned during the Stated Preference choice part of the study that if they could not drive to get groceries, they could get them delivered.

Several participants talked about how they would delay individual objectives until there were several reasons to go out. For example, one man recalled how he would usually walk to the coffee shop to meet his friend. Instead, he decided to drive so he could continue after the coffee meeting to pick up a heavy item that he had been waiting to purchase.

Driving Companions

In addition to walking and transit, a few participants said they routinely travel with others for social reasons. These were often scheduled trips to regular events and the individuals involved would take turns driving. In some cases, the participant was the only driver amongst a group of individuals. Only two participants said they use a bicycle on a regular basis for transportation. Taxis were rarely or never used, mainly because of the cost, but one woman said she did not trust taxi drivers to be honest with elders about the fare.

Alcohol Consumption

Five men mentioned alcohol consumption affected their driving decisions. Although all insisted they did not drink regularly, these men said that in the few occasions they had consumed alcohol it would be the primary consideration in their decision. Some said that if they had any alcohol at all they would not drive and that they always planned

ahead for this by arranging alternate transportation (taxi, designated driver, walk). Two men said that they would drive after a glass of wine with dinner if enough time had elapsed.

7.3.2. Stated Preference Task

When faced with complex problems such as where, when, and how to travel in order to fulfill a goal, individuals are presented with a large amount of information to consider in their decisions. Decision Theory tells us that people can attend to only a few pieces of information at a time, and that individuals vary in their styles of decision-making, including differences in the types of information used and the weight placed on different items of information. This task aimed to explore what information participants use, and how participants use different types of information in a hypothetical decision of whether or not to drive.

This task involved deciding whether or not to drive in two different scenarios (Scenario A and Scenario B), and then choosing the one in which you would be most likely to drive. Types of information presented in the scenarios included *Motivators, Constraints,* and *Contextual Factors* in different combinations. Descriptions of the scenarios and responses are presented in Table 1 of Chapter 6 METHODS. Scenarios used in the study are presented in Appendix H.

Most of the participants completed this task without difficulty, but there were a few who struggled. These individuals had difficulty imagining a situation that was different from their own, so would initially make decisions based on their own circumstances rather than those depicted in the scenarios. For example, they might respond, "*I always walk to my doctor's*" even though the scenario described the distance as "*across town"*. When this happened, participants were reminded to consider only the information presented in the scenario. In almost all cases the participant was able to accommodate, but there were a few times when they could not. This occurred most often with participants who stated they are never sad and depressed so could not imagine how this would affect their decision.

In some cases, a participant insisted that they would drive in both scenarios and that they would not make a choice about in which scenario they would be most likely to drive. This occurred with participants who scored High on the Self-Reported Habit Index

for driving. For these individuals, there was no reason depicted in either scenario to make them even consider not driving. The same did not occur for participants who initially said they would *not* drive in both scenarios. In these cases, all respondents said that they would "take a chance" and drive in one of the scenarios.

Qualitative Analysis

Explanations, given by participants, of why each choice was made were reviewed for meaning and categorized according to type of information. Six main categories were formed: reasons for the trip; alternatives to driving; health; the driving environment; criticisms of their driving; and driving skills and abilities. Upon reviewing the data it was found that the same information items were sometimes used for two opposing reasons: to support or to deter driving. Accordingly, the information was also categorized according to whether it was used to support the decision to drive (Support Driving), or to rationalize not driving (Deter Driving).

Significant differences were noted in the proportion of information used to support versus deter driving (Figure 13). The reason for the trip, and environmental items (e.g., good weather, distance, light traffic) were more likely to be used by both men and women to support their decision to drive. Items dealing with poor health, criticism from family or doctor, and lack of transport alternatives were more likely given as reasons not to drive. There was less difference in the use of information about driving skills which included both objective (crash or near-crash) and subjective (self-appraisal of driving) skills, with men more likely to use this type of information to deter driving while women were slightly more likely to use it to support driving.

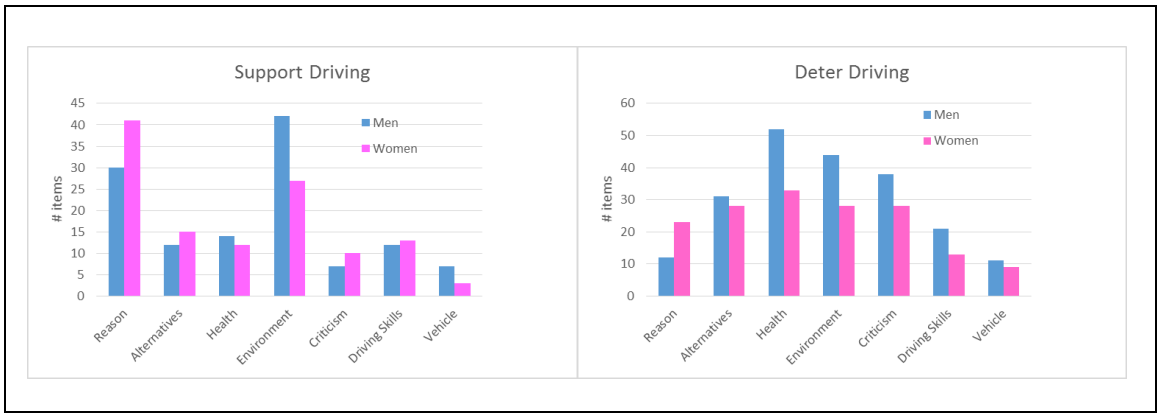


Figure 13. Number of scenarios using information types

As participants selected in which scenario they were most likely to drive, there was often inconsistency in the way they used the same information in different scenarios. In particular, interpretation of the factor "*Your doctor has warned you that you should give up driving soon,*" changed, even within the same individual, especially in response to the reason for the trip. In scenarios where the participant evaluated the trip importance as minor, the doctor's warning was used as a reason not to drive. However, if the trip importance elevated, for instance to visit a friend that they had not seen for 6 months, the importance of the doctor's warning was minimized. For example, in one scenario a participant said, "*If the doctor warns you, you should give up driving immediately,"* whereas in another scenario he responded, *"Well, it was just a warning that soon you should consider it. What does soon mean?"* Similar behaviours occurred with *"Your family has recently criticized your driving.*" Whereas in some scenarios a participant said, "*You have to listen to your family"*, under other conditions the same individual decided to drive despite the family criticisms.

Differences between participants in how the same information was used resulted in different choice outcomes. For example, some participants said they would *not* drive because the destination was only one mile (so they could walk), while others said they *would* drive because it was only one mile. The latter occurred more often when other high level factors of concern, especially poor health, were included in the scenario. In these cases, participants said they would "*take a chance*" or "*risk it*" and drive despite the

adverse conditions because it was only a short distance. This suggests some drivers weigh the risk of negative outcomes according to time/distance of travel and familiarity with the route. Another example involved the item "*You are just getting over having a cold*." Some participants said they *would* drive because they were starting to feel better while others said they would *not* drive because they always felt worse towards the end of a cold.

Some of the scenarios contained several discouraging items and participants noted all of them as reasons for not driving. When asked, they said that it was the combination of factors that are important, not just one single factor alone. This was especially true for health related items. For example, "*You rear-ended another car a few days ago"* was not given consideration when it appeared alone, but when it appeared in combination with negative health-related factors (e.g., shortness of breath, arthritis) it was included in the decision not to drive.

Gender Differences

Gender differences across responses suggest women are affected more than men by criticism of their driving, crash risk, and health. All of the women said they would avoid driving in one scenario (3.1) that included family criticism, a near-crash with a pedestrian, heavy rain, going to a new place, and neck arthritis, whereas only 70% (n=14) of males did not choose to drive in this scenario (p = .024). Both women (94%, n=15) and men (50%, n=10) said they would prefer not to drive in a scenario (2.1) that included a doctor's warning, a recent rear-end crash, shortness of breath, and a journey across town (p=.009). Further, a scenario (2.2) that discourages driving with getting over a cold and family criticism but also entices driving with a new vehicle was avoided by 40% (n=8) of men but by 75% (n=12) of women, indicating men were more motivated to drive a new vehicle (p=.049).

Gender differences were also evident in that women were much more homogenous in their choices. In every choice set, the scenario with the highest value of reason for the trip was selected by the majority of participants. However, women were much more likely to display this pattern: the proportion of women choosing the high-reason scenario ranged from 56%-100% while only 35%-50% of men chose high-reasons scenarios. This suggests women are much more likely than men to give more weight to

the reason for a trip in making their driving decisions. This was evident during the course of the research wherein women spoke more frequently and in more detail about the relative importance of the trip reasons in each scenario.

Habit Strength Differences

The data were reorganized according to Habit Strength groups developed from the SRHI (Section 7.1.6). As a group, participants in the Low Habit group appeared to place more weight on health related information, avoiding driving in scenarios depicting poor acute or chronic health and a doctor's warning. The latter was especially salient, as during the task most of the individuals in this group exclaimed that they would immediately stop driving if their doctor made any suggestion that they were no longer capable. Participants in the Low Habit group also appeared to give more consideration to driving skill information, especially causing a recent crash.

In contrast, participants in the High Habit group had more difficulty choosing a scenario where they would be less likely to drive, and in two scenarios one male and one female refused to choose, insisting there was no reason not to drive in either. When pressed to choose, participants more often considered the reason for the trip since the other factors such as weather, distance, and minor health issues were of less concern. They were also more likely to choose to drive in the scenario that included a new vehicle. These results suggest that many of the High Habit group individuals give more weight in their decisions to intrinsic information about the driving experience.

Summary

Most individuals completed this task well and were able to choose when they would be most likely to drive. The exceptions were two High Habit individuals who would not choose one of the options, insisting that there was no reason not to drive in either choice. Some individuals said they could not relate to particular items, especially depression, so they disregarded this information.

Habit strength also appeared to affect how the information was used. Participants in this study who were classified as Low Habit for driving tended to place more importance

on health information (*Constraints)* and objective driving skill information (*Contextual Factors*). Participants classified as High Habit used less *Constraints* information about health and driving environment and more *Motivators* such as the reason to travel, and vehicle information.

Strong gender differences emerged in the use of information regarding the reason for a trip, with women being much more likely to consider this type of information, especially if it involved social activities.

It is clear from the data that different individuals interpret and use the same information in different ways. For example, the distance of a destination may be used to support driving by one individual but deter driving by another. It is also clear that the same individual may use information differently under different conditions. Therefore, it appears that although some general trends were observed in types of information used in making decisions, the process is a dynamic one that is affected by in-time circumstances.

Furthermore, it appears that the same information may be given more weight if it appears in combination with other information. For example, a recent rear-end crash was given very little consideration if all other conditions were good, but in combination with poor health and bad weather, the importance of the rear-end crash information was enhanced.

Together, these findings have implications for the proposed Older Driver Decision Components Framework (Section 4.2) used to guide this research. In the framework, *Constraints* are conceptualized as factors that deter decisions to drive and include items such as poor road conditions and declining health. However, results of this analysis clearly show that the interpretation of *Constraints* information is person-centered, situation-dependent, and perhaps also time-influenced. For example, although some individuals evaluated poor weather as a driving deterrent, others were enticed by the excitement of driving in challenging situations. Further, combinations of other factors changed their appraisal of the value of weather. Therefore, information items included in the *Constraints* portion of the model may be used not only as deterrents but also as motivators for driving.

From these results it became evident that it was necessary to modify the Older Driver Decision Components Framework to clarify the dynamic use of these types of information. A revised model is presented next, in Section 7.3.3 below. Subsequent analysis of the Information Preferences Task and statistical analysis of the Stated Preferences task were conducted within the context of this revised model.

7.3.3. Revised Model

A preliminary model of older driver decision-making was developed to guide this research (Chapter 4.1, **Older Driver Decision Components Framework**). Based on results of the research, a revised model is offered (Figure 14).

The revised model incorporates several key findings about how information is used by elders in making their driving decisions. First and foremost, driving decision-making is seen not as a linear process wherein individual items of information are considered, evaluated, and either used or ignored. Instead, decision-making is seen as an iterative or integrative process wherein items of information are connected in various combinations, considered, recombined, and re-evaluated until a successful combination is accepted. This is represented in the model as the dashed-line circle connecting all types of information. The driving decision is seen as being made within that sphere of deliberation, after final evaluation of the trade-offs between the goal and the risks associated with driving.

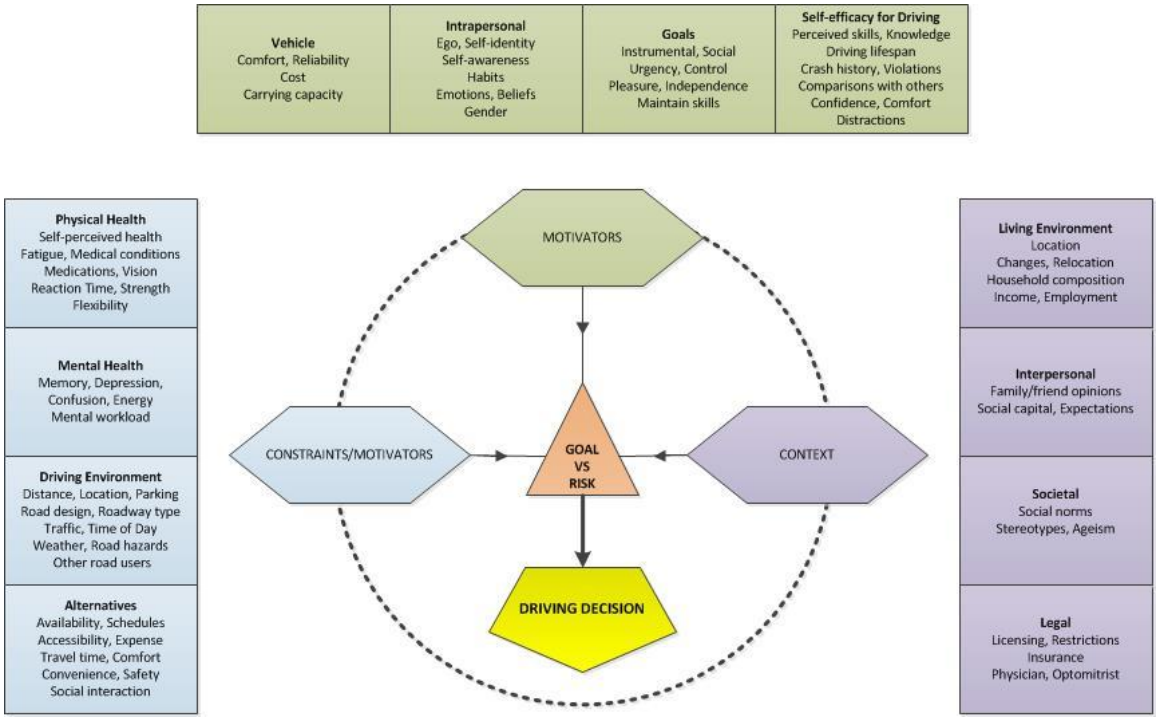


Figure 14. Older Driver Decision Components Framework II (Revised)

Second, this model recognizes the dynamic use of some types of information, especially *Constraints.* This research revealed information items of health, the driving environment, and alternatives to driving were sometimes used as *Constraints* that obstruct or prohibit driving, as outlined in the original model. However, the research demonstrated that these items may also be use as *Motivators* that support decisions to drive. These items are thus depicted in the model as *Constraints/Motivators* reflecting their dynamic use. The changeable use of these factors is influenced by *Context* and *Motivators*, as represented by the sphere connecting them.

Third, some of the information items in this model have been adjusted. *Motivators* and *Context* are now believed to be more stable on a day-by-day basis. This is not to say that over time, or as a result of a significant event, that they do not evolve. For example, there is some evidence in this research that self-identity associated with driving may weaken over time, however it is not believed to fluctuate dramatically from one day to the next or within the same day. In contrast, the evaluation of *Constraints/Motivators* may change daily as a result of circumstances. For instance, this research demonstrated that a short distance of travel acted as a deterrent to driving (replaced by walking) when the

elder felt good, but as a motivator to driving when the elder had symptoms of a cold. Accordingly, Alternatives to Driving were included as *Constraints/Motivators* while Legal Factors were included in *Context.* An additional category, Living Environment, was added to *Context* to include the finding that differences in residence, living arrangements, and employment provide a background that affects interpretation of other decision factors.

Finally, the factor 'Negative Consequences of Not Driving', presented in the original model, is subsumed in the Instrumental and Social Goals factors of the revised model. Gender is also added as a *Motivator* to reflect the important differences found in this research. Self-efficacy is included as a *Motivator*, and embraces the individual's perceptions of their own driving skills and abilities acquired from their driving history, comfort with driving, knowledge about driving, and perceived ability to deal with a complex driving environment.

The revised **Older Driver Decision Components Framework II** is applied to the following analyses to aid the understanding of differences between various groups of decision-makers in this study.

7.3.4. Information Preferences Task

The Information Preferences task provided cued information for participants to choose items that they consciously use in decision-making. When prompted by the cards, most participants revealed additional information not freely recalled during the interview process. Thirty-five types of information were presented; one additional type of information, identified in the interviews but not originally provided in this task was time in transit. This included a comparison of time spent getting to a destination by various modes, and also whether the individual was "*running late*" and thus had insufficient time to wait for transit or to walk.

The Older Driver Decision Components Framework II proposed for this study outlines three categories of decision-making information. The main category of information that participants said they considered in their decisions involved *Constraints/Motivators* (73%). *Motivators* (25%) also represented a significant amount of information used, but *Context* (2%) were rarely chosen (Figure 15).

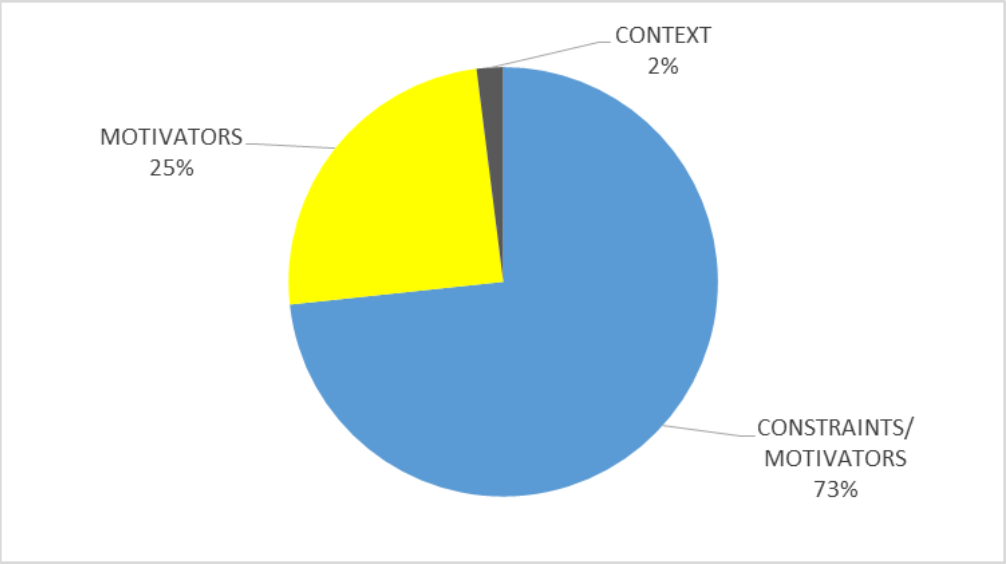


Figure 15. Proportion of Information Categories used in driving decisions

Motivators are conceived as items that support decisions to drive. They include items such travel goals, intrapersonal factors, vehicles, and self-efficacy for driving. *Constraints/Motivators* are represented by items that often form barriers to driving but may also be used to support driving, depending on the circumstances. They include items related to physical and mental health, the driving environment, and alternatives to driving. *Contextual factors* include interpersonal and societal attitudes as well as legal issues and the individual's living environment.

Number of Items Used in Decisions

The difference is not statistically significant between men (mean 8, range 3-15) and women (mean 7, range 1-12) in the number of items chosen.

There was no difference between individuals with High or Medium scores for Habit Strength for the number of items considered in their driving decisions (mean 6). However, participants who scored Low on the SRHI cited more items (average 12) that they considered in their decisions.

It was expected that physical declines, as indicated by walking speed, might be associated with number of items used in making driving decisions. Healthy individuals likely do not include health information in their decisions about driving, so it was expected that poor health would result in the consideration of additional items. However, examination of the TUG score did not show any apparent correlation (Figure 16).

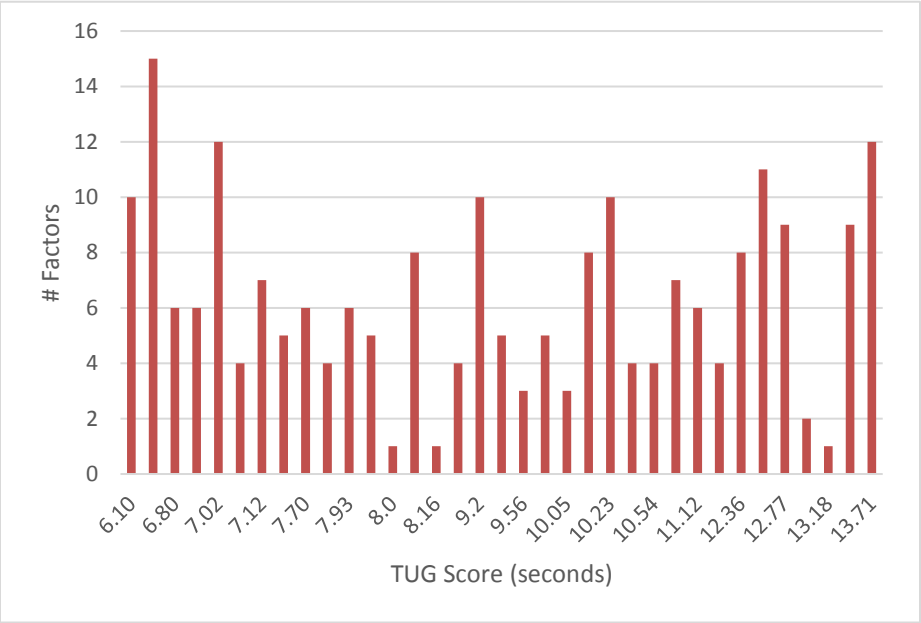


Figure 16. Number of decision items by TUG score

Information Items

In total, 21 items of information were chosen by the participants (Figure 17). Twelve items were from the *Constraints/Motivators* category, six from the *Motivators* category, and three from *Context*.

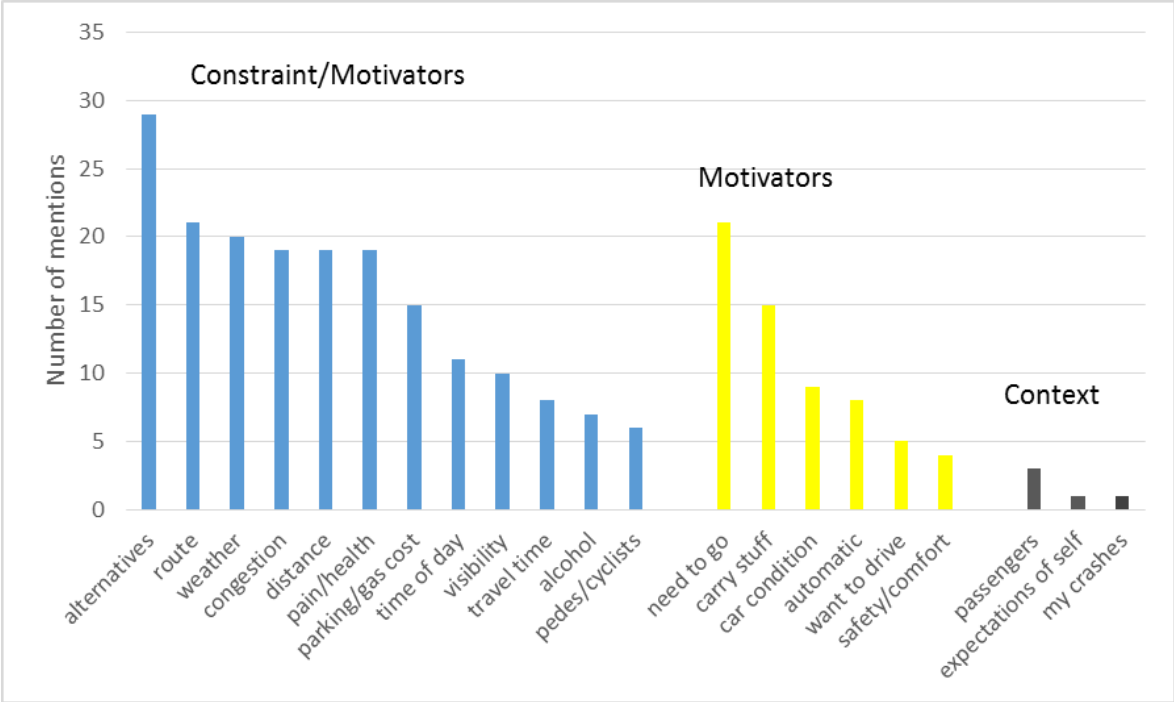


Figure 17. Information items used in driving decisions

Constraints/Motivators

Twelve types of *Constraints/Motivators* were identified by participants as information they consciously considered in making decisions to drive (Figure 18). Alternatives to driving was the single item cited most frequently (16%). Alternatives included transit availability, practicality of transit, and other ways to get there such as walking, cycling, or getting rides from others. However, as a group, *Constraints/Motivators* dealing with the driving environment dominated (58% of *Constraints/Motivators*), and included the weather, the route and traffic congestion which were often cited together, visibility, the presence of pedestrians and cyclists, parking, and distance. Distance was most often spoken about in relation to walking, but also sometimes in regards to drivability wherein some individuals were willing to drive only short distances. Parking was considered a significant factor in decisions about whether or not to drive into downtown areas (especially downtown Vancouver) and included availability of parking. Being able to

maneuver a vehicle into a parking space was not considered an issue, and in fact several participants took pride in their skill. Compared to environmental conditions, consideration of health factored much less in their decisions. Included in this category were physical and emotional wellbeing, reaction time, energy level, pain, and concentration (14% of *Constraints/Motivators*).

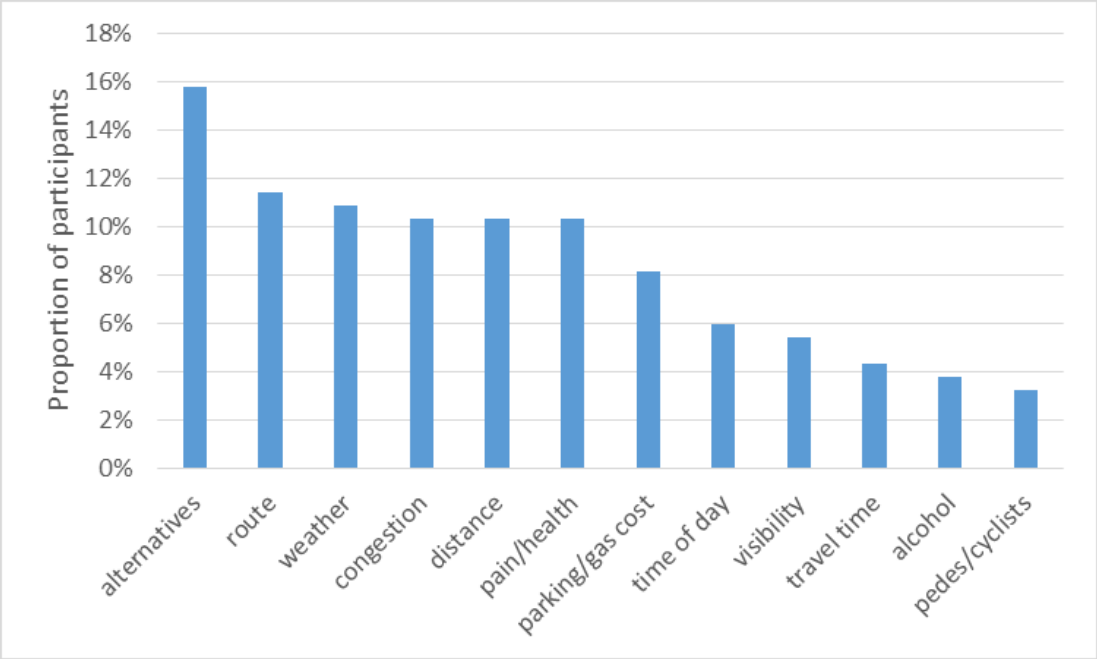


Figure 18. Proportion of participants using *Constraint/Motivator* information, by type

Motivators

Six categories of *Motivators* were identified (Figure 19). By far, *Need to Go* was the most commonly cited factor in deciding whether or not to drive (34% of *Motivators*). Needing a vehicle to carry things, such as groceries, moderated the consideration of alternatives to driving, as did the travel time for driving versus transit. For a small proportion of participants (13%), decisions to drive were made with little deliberation, considering mainly the “need to go”, “want to drive”, or “I just automatically drive”. Linking trips was mentioned by several participants, so that if there were several missions to

accomplish, driving became the automatic response. *Motivators* related to the vehicle (condition of the vehicle, comfort of a car) were sometimes considered.

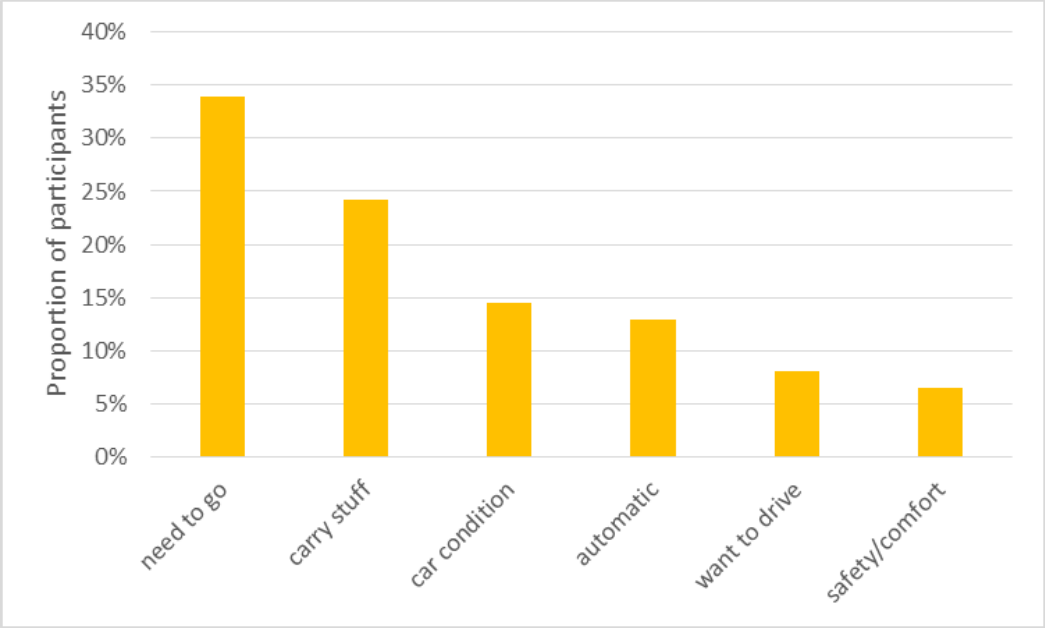


Figure 19. Proportion of participants using *Motivator* information, by type

Context Information

Context information appeared to be minor considerations in the driving decisions, cited by only 3 participants (8%) (Figure 20). The needs of passengers, expectations of self, and a recent crash were included.

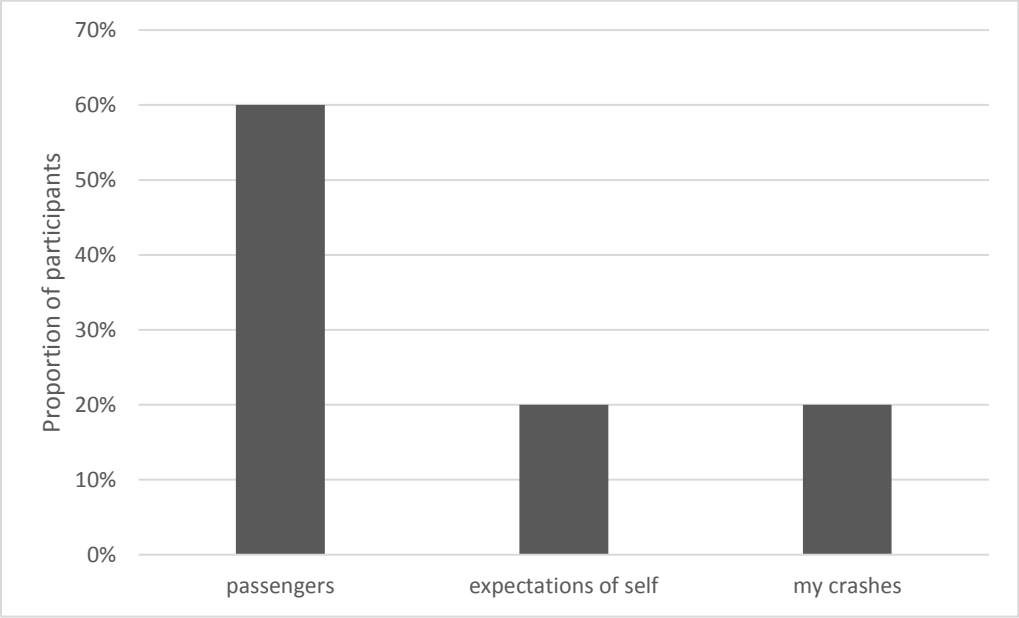


Figure 20. Proportion of participants using Context information, by type

Excluded Items

Of the 35 items presented in the Information Preferences task, 9 were not chosen by any participants. Items not chosen are presented in Table 7. A few participants commented that "driving is not a right."

Table 7. Items not chosen in making driving decisions

CATEGORY	ITEM
Constraints/Motivators	Am I capable My memory My medications Making left turns Police
Motivators	Cost of Not driving
Context information	Others' expectations My right to drive My traffic tickets

Relative Importance of Item Categories

Analysis was done of the top three items chosen by the participants (Figure 21). “Need to go” was rated most often as the most important item in decisions to drive. It was also included as second and third most important item so, altogether, it ranked first with 14% of the ‘votes’. “Need to go” is classified as a *Motivator*. Other *Motivators* that were chosen included the need to “Carry things”, “I Want to drive”, “I automatically drive,” and items dealing with vehicle comfort and cost. In total, *Motivators* comprised one-third (37%) of the items considered most important in making decisions to drive.

Although traffic congestion was not rated as most important by any of the participants, it was rated second and third in importance so that overall it was the second most important item in decisions. Other major considerations included the weather, the route, distance, time of day, and visibility. All of these items are classified as *Constraints/Motivators*; they represent approximately two-thirds (64%) of the top decision items.

There were no *Context* items included in the top three most important considerations in driving decisions. *Context information* includes interpersonal and societal norms and expectations, legal aspects, and items related to the living conditions of the driver. In fact, *Context* items were rarely cited at all in making driving decisions.

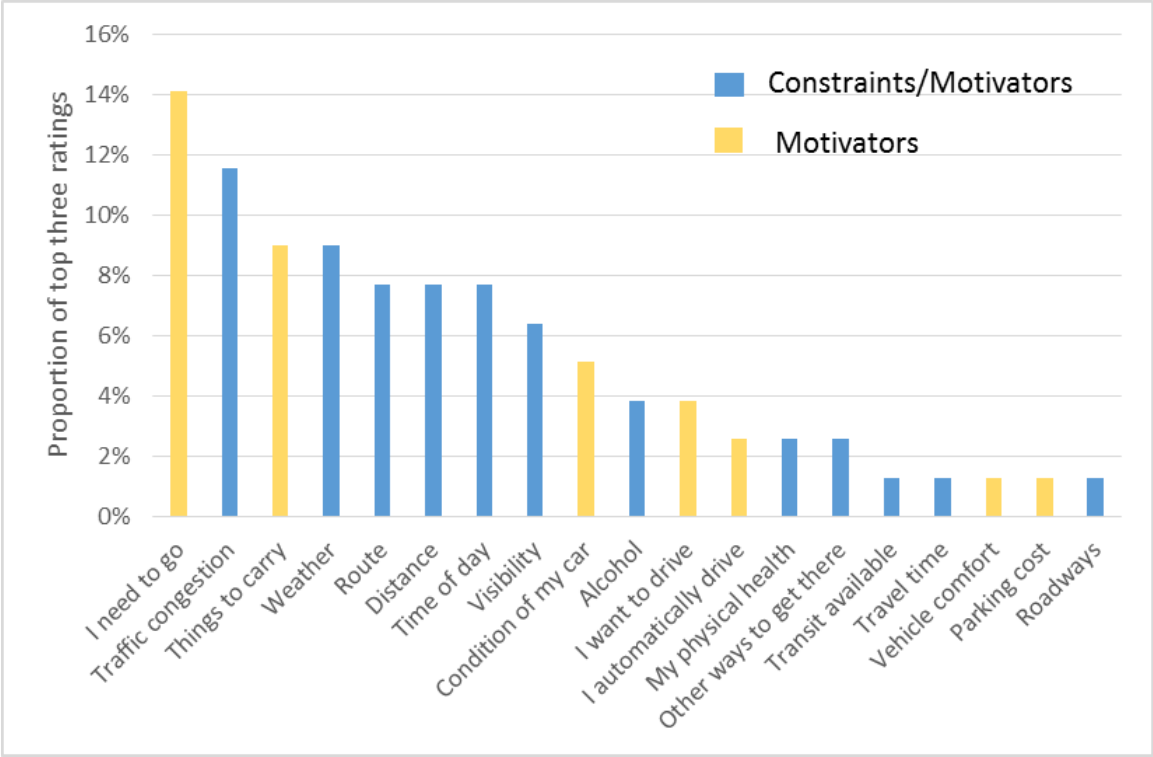


Figure 21. Proportion of items chosen as top three most important

When examined by Habit Group, some differences were noted (Figure 22). For participants in the High Habit group, *Constraints/Motivators* comprised slightly more than half (56%) of the high priority items and were mostly items dealing with the driving environment. However, the most common item was “I need to go”, representing 14% of the responses. When combined with “I want to drive” and “I automatically drive”, these *Motivators* made up almost one-quarter (23%) of the top priority information items.

The top priority item for the Low Habit group was also “Need to go” and represented 20% of the responses, however, “I want to go” and “I automatically drive” were not selected by this group.

Goal type *Motivators* comprised only 14% of high priority items for the Medium Habit group; “Need to go” represented only 8% and was the fourth priority item. For the Medium Habit group the main items were *Constraints/Motivators* and included traffic congestion and weather (14% each), route and time of day (11% each), distance (8%) and other items. The Medium Habit group was also the only group to choose “Transit

available" (3%) among top priority information used in driving decisions. Analysis by gender revealed no differences between men and women.

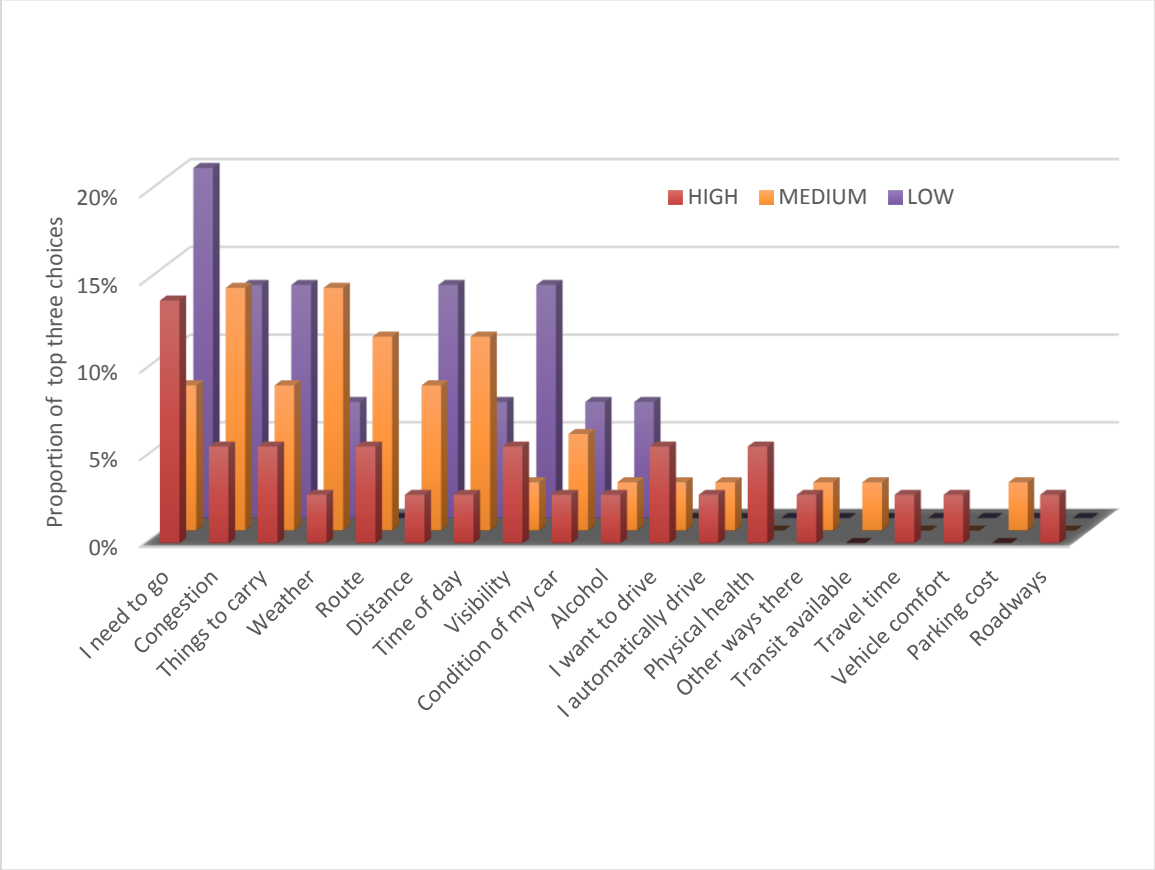


Figure 22. Proportion of high priority items, by Habit Group

Summary

Twenty-two different types of information items were chosen by participants as regularly used in their driving decisions. The items that participants identified could be classified into the three categories of the Older Driver Decision Components Framework II. Of these, the majority could be considered *Constraints/ Motivators* (73%) and *Motivators* (25%). Participants used very few *Context* items (2%) in their decisions.

No association between poorer health (measured by TUG score) and the number of items used in decisions was found, suggesting drivers that are more frail do not use more information in their travel decisions. It is possible that rather than considering additional information items, drivers with poorer health substitute health information for other types of information used by healthy individuals, so the total number of items remains relatively constant, at least within a relatively small range. The psychology literature has amassed a wealth of evidence to suggest that humans rely on the use of quick mental processing rules known as heuristics to manage everyday decisions. Heuristics are used by decision makers to reduce the amount of information considered, especially during complex choices (Leung & Hensher, 2012). Results of this study lend support to the belief that people limit the amount of information they use in decisions.

The need to travel, traffic congestion, and the need to carry goods were considered by the participants in this study as the three most important items used in making driving decisions. In total, *Constraints/Motivators* represented almost two-thirds (63%) of the high-priority items and *Motivators* represented 37%. *Context* items were not considered as priority information in the driving decisions of these participants.

Results of the Information Preferences task showed no differences between men and women for categories of information, but differences were noted across habit strength as measured by the SRHI. Whereas both High and Low habit drivers considered "Need to go" as the most important item in making decisions, High Habit drivers also included *"I want to go"* and *"I automatically drive"*, while Low Habit drivers did not. In other words, high habit scores in this study are reflected in the higher use of automatic intentions and behaviour. Interview results also support the interpretation that Low habit individuals drive mainly when they perceive a pressing need to accomplish a task, whereas High habit drivers consider almost any task as a need that they wish to accomplish by driving. In contrast, Medium Habit drivers consider alternative means of transportation (transit) so that the need to go becomes less important in driving decisions. Instead, *Constraint/Motivator* items, primarily driving conditions such as weather and traffic congestion, are given more consideration.

7.3.5. Cluster Analysis

Although some differences were seen across genders and habit scores in how the participants used the information presented in the scenarios, the large amount of data made it difficult to determine whether individuals could be categorized according to their actual choices. TwoStep cluster analysis (SPSS©, 2001) was used as an exploratory tool to uncover possible groups of individuals with similar patterns of decision-making. Since cluster analysis is primarily an exploratory tool, the results should be considered suggestive.

TwoStep cluster analysis of the decision scenarios produced three groups of similar sizes. Gender, age, and SRHI Habit Score were entered as Evaluation Fields rather than as variables because a solution based on stated preferences alone, rather than including personal attributes, was preferred. Although cluster analysis does not have any goodness of fit measures of test of significance, SPSS© produces a silhouette measure of cohesion and separation for the model representing the tightness of values within each cluster and the distance between clusters. The first model produced by the analysis was rated “Fair” by SPSS©. When 15% outlier treatment was allowed, resulting in 7 outliers, the model quality improved to “Good” (Figure 23). Although this resulted in a smaller sample size, the model with the better fit (without outliers) was chosen. Selecting a model with the best fit would be more interpretable because of better homogeneity in each cluster.

Model Summary

Algorithm	TwoStep
Inputs	12
Clusters	3

Cluster Quality

Figure 23. Final SPSS© output of TwoStep cluster analysis

All variables contributed to the model with the choice of Scenario 1.2 being most the important (Figure 24). Scenarios 2.1 and 3.1 were least important in the model.

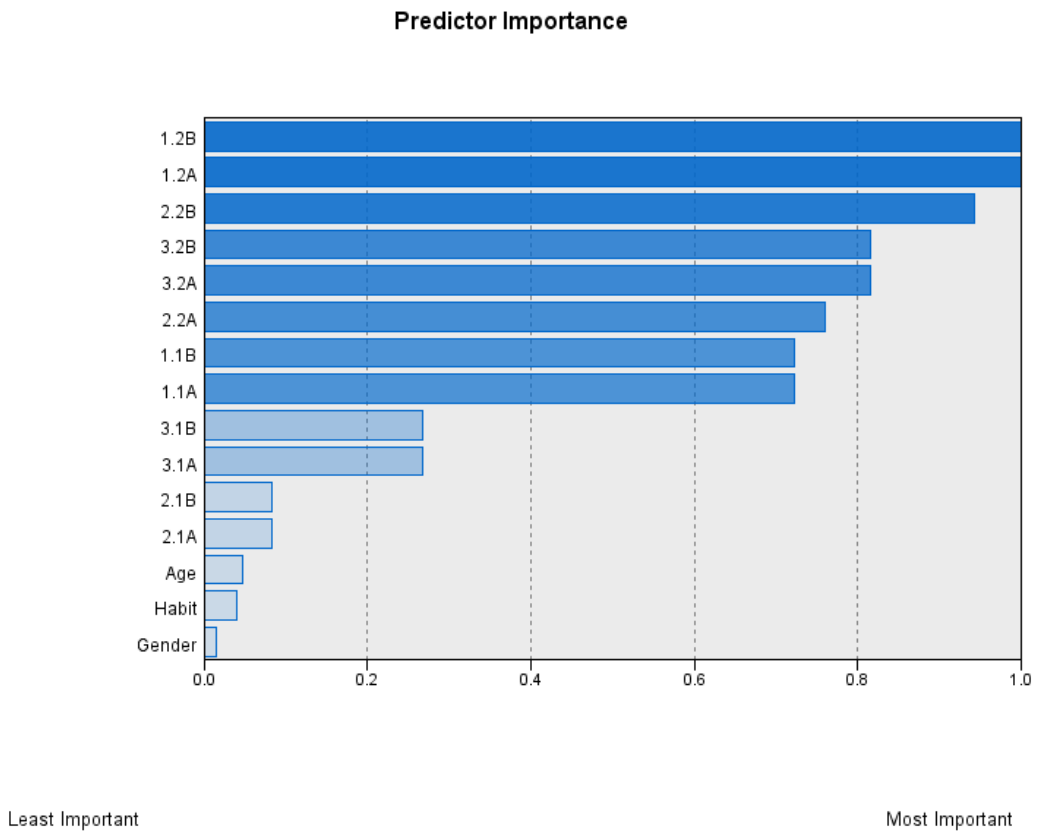
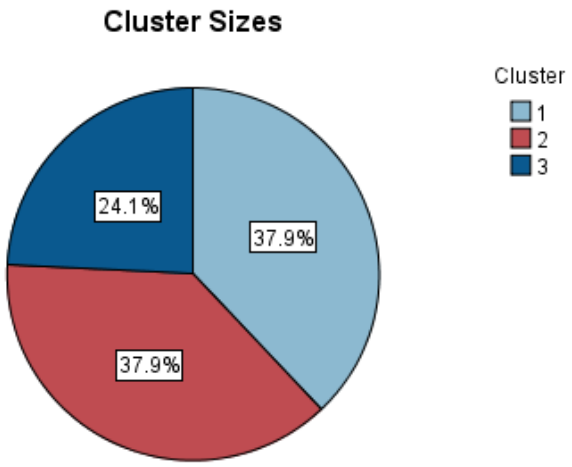


Figure 24. SPSS© output of predictor importance

Cluster Solution

A 3-cluster solution was created based on common responses to choosing scenario A or B in each choice set (Figure 25). The ratio of cluster sizes was good: two of the clusters were of equal size (n=11) and one was smaller (n=7).



Size of Smallest Cluster	7 (24.1%)
Size of Largest Cluster	11 (37.9%)
Ratio of Sizes: Largest Cluster to Smallest Cluster	1.57

Figure 25. Three cluster solution

Cluster Attributes

The dominant choices made for each cluster are illustrated in Figure 26. Examination of the Evaluation Fields shows that Cluster 1 and 3 were slightly more likely to be female and younger, and to score higher on habit strength. Mean age for Cluster 3 was older, and Cluster 2 was younger than Cluster 1.

Comparison of the stated preference choices in each cluster showed considerable overlap, with each cluster making similar choices to another in most of the scenarios. However, for each cluster there were some unique choices that helped define the groups, as discussed below.

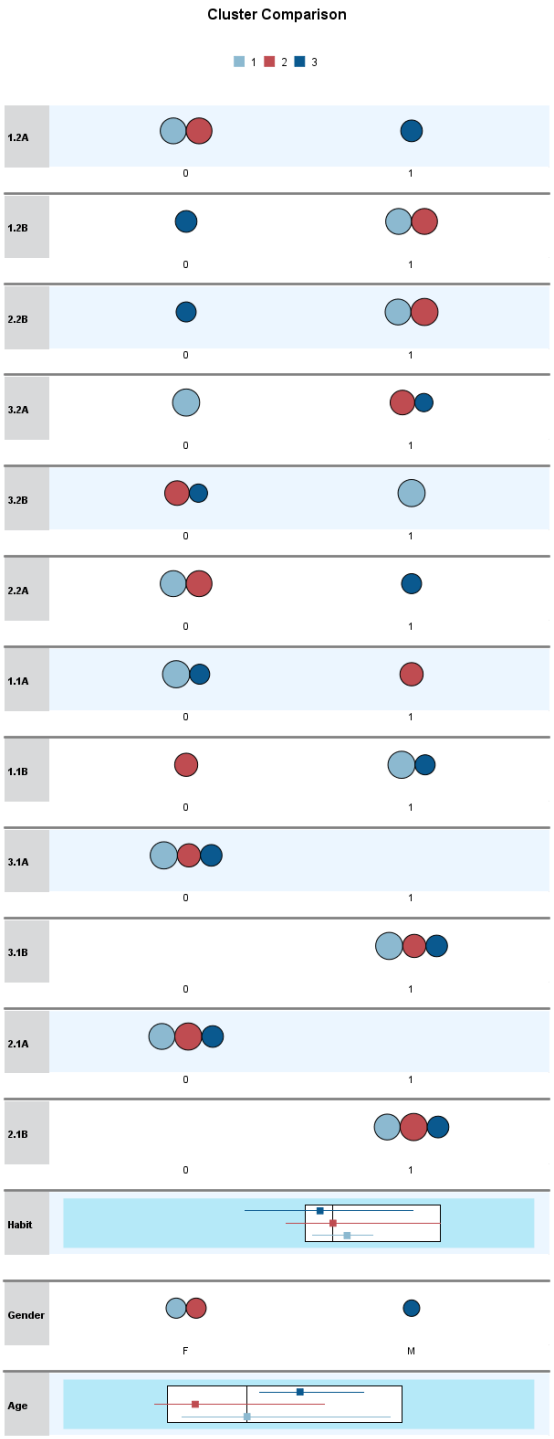


Figure 26. Cluster attributes

To aid in interpretation of the analysis, the survey data and qualitative data collected earlier were reviewed. The demographic data collected during the introduction part of this thesis revealed no statistically significant differences in mean age, TUG walking speed, number of driving days, or mean hours of driving, across the clusters. A comparison of mean SRHI scores using ANOVA also detected no statistically significant differences in means between the clusters ($p = .66$). However, the small sample size limited the statistical power of the analyses. Twenty-one participants would be needed in each group to detect a large effect size (Cohen's $d > .8$) between means (1-tailed, 80% power, 95% confidence).

The health and driving habits data, when examined across clusters, produced very small sample sizes. The z-test for proportions with Bonferroni correction was used with level of significance set at 90%. The small number of individuals in each cluster and across responses did not allow detection of statistically significant differences. However, some suggested tendencies were noted in the data, as presented below.

Cluster Descriptions

Following is a summary of cluster characteristics, including the attributes revealed in the cluster analysis and tendencies seen in the survey data. Since cluster analysis is an exploratory tool, and since sample sizes were small, attempts to define the clusters of different decision-making styles are proposed rather than clearly defined. Further work is needed to confirm and clarify these results.

Attempts have been made to characterize the clusters with a decision-making style, reflected in a title assigned to each cluster.

Following each description, a Case Study is presented. These case studies describe one individual who most closely represents the characteristics the cluster. Fictitious names were used in the case studies to protect the privacy of the participants.

CLUSTER 1 – Relationships Rule

Cluster 1 was defined by their unique response to Scenario 3.2. This scenario presents a choice between a low-level social need in A (festival in the park) and a high-level social need in B (rare meeting with an old friend).

All of the participants in Cluster 1 chose B, to meet an old friend whom they had not seen for 6 months. The overwhelming reason cited for choosing Scenario B was that it is more important to see old friends in a personal setting than to go to a festival. The difference in quality of interaction between casual meetings at a festival and in-depth conversation with a close friend was considered paramount. Additionally, most of these individuals said they would take advantage of the free taxi/bus voucher in A so would not drive. However, they would not take the bus in Scenario B.

Individuals in Cluster 1 chose to ignore or rationalize the element *"your doctor has warned that you should consider giving up driving soon"*, in contrast to other clusters where the doctor's warning was considered most important. Statements made included, "*I want to see my friend. Even though the doctor warned me, I want to see my friend so would drive",* "*The doctor said I should consider it not that I must. So I'll consider it while I drive*", and, *"What does 'soon" mean? Next week or next year?"* Some pointed out that the scenario included *"you are totally capable*" and "*you consider yourself as good a driver as others your age*". They interpreted this as support for the belief that doctors don't really know much about their patients' driving. Others pointed out that since it was Sunday morning the traffic would be light and driving would be less risky, reducing the significance of the doctor's warning.

Cluster analysis revealed that this cluster tends to be female, have the highest habit strength for driving, and has a mean age between the other two clusters. Tendencies noted in the participants' survey data revealed individuals in this cluster were more likely to rate themselves as a bit healthier than others of the same age. They were not limited climbing three flights of stairs. They drove a bit slower than the flow of traffic, and never avoided rush hour or bad weather. Three individuals in this cluster were still working at the time of the study. One of the 11 individuals in this cluster had lightly bumped the car within the past 6 months.

The individuals in this cluster appear to be highly influenced by social factors in their driving decisions. To fulfill their social needs, they have developed a strong habit for driving to activities and events that are not easily accessible by transit. Since their social connections are important, they do not give much consideration to factors such as driving conditions or comments from others in making decisions to drive. Three individuals were still working, underscoring their social connectedness and habitual driving for work.

Case Study for Custer 1

Diane is a 74-year-old woman who lives alone in an immaculate, modernly furnished apartment. She is slim, attractive, well-groomed and very personable. She retired from full time nursing but continues to work part time for extra income, but also to remain connected to people.

Diane loves the independence that driving gives her. She drives to Calgary to visit her daughter and while there helps to transport her grandchildren to their events. Diane says, "*I always want to drive*." Her SRHI score was very high at 55.

During the card sorting task, Diane created 10 piles, half of which she described in terms of people. During the choice scenario task, family criticisms and health were strong factors in her decisions, reflecting her social connections and professional orientation. "I want to drive", "weather" and "traffic congestion" were top factors that she chose in the Information Preferences task, and she said she would be highly influenced by more than half of the statements her grandson may say about her driving.

In her driving decisions, Diane primarily considers her reason to go and her desire to drive (i.e., *Motivators*). These are somewhat moderated by the driving conditions at the time (*Constraints/Motivators*) that may delay rather than inhibit driving.

CLUSTER 2 – I'll Drive If I Have To

Cluster 2 was defined by its unique response to Scenario 1.1. In this scenario participants are presented with a choice between a low instrumental need in Scenario A

(regular blood check) and a high instrumental need in Scenario B (most important medication). The majority (73%) of respondents in this cluster chose A, whereas none of the participants in Clusters 1 or 3 made that choice. Individuals in this cluster seemed to be less motivated by the purpose of the trip than other clusters.

The main reason given for choosing A was that there was no alternative to driving, suggesting these individuals consider different transportation modes. Although the scenario described "*you are just getting over a cold"* and "*you rear-ended another car a few days ago*", participants rationalized that since it was a sunny day and the destination was only one mile away, the risk would be minimal. Attitudes included, "*It's close and I've been there before. The rear-ender is not a problem. Maybe I'll be more careful,"* and *"There is nothing to stop me from driving in either, but there is no alternative in A".*

Participants in this cluster avoided driving in B mainly because *"neck arthritis makes it hard to turn your head sideways.*" These individuals felt that it was critical for safe driving to be able to watch for other vehicles, and they were certain they would not drive if they could not turn their head. Three noted that a bus was nearby in B, highlighting their consideration of alternate transportation. One woman noted that being out of an important prescription would affect driving ability, and so she would take the bus.

Tendencies noted in the participants' questionnaire data revealed individuals in this cluster were more likely to rate their health as very good/excellent and much healthier than others their age. They don't often feel tired or worn out, but are limited a little climbing three flights of stairs. They tend not to drive slower than the flow of traffic and never avoid driving in the dark. Three of the 11 individuals in this cluster has lightly bumped the car within the past 6 months.

Members of this cluster tend to be younger females with medium habit for driving. They make use of public transit and drive only when needed. This likely contributes to reduced driving practice and consequently to reduced skills and/or confidence as demonstrated by slower driving and minor crashes. Alternately, their health may be reduced, as demonstrated by limitations climbing stairs, which may have affected their driving skills.

Case Study for Cluster 2

Elaine is a 70-year-old woman who lives in a condo apartment with her husband. She worked as a lab technician before raising her family, so drove a lot with her children and grandchildren including long trips. She rates her health as about the same as others her age, is occasionally tired or worn out, and only occasionally full of energy. Elaine enjoys music and plays clarinet in a community band.

Elaine's habit strength for driving is 38, placing her at the low end of the Medium category. She says, *"I wouldn't like not driving. It wouldn't be a huge deal but I wouldn't like it."* She drives twice a week for a total of about 2 hours. Her husband is the primary driver and when he is not available to drive she rarely takes transit but drives herself.

In choosing factors used in making decisions, Elaine said she considers the route, traffic congestion, and the distance as the most important factors. She avoids routes where she knows there will be a lot of pedestrians or cyclists suggesting her driving skills are somewhat challenged. In fact, she responded that her confidence in driving is "average" and her quality of driving is "good". During the card sorting task Elaine pointed out that she doesn't like confusing road signs, aggressive drivers, and tight parking spots and she relies on her GPS to help navigate as she drives.

Although Elaine is capable of driving, she drives only when she has to, and then only if she considers the driving environment is manageable. Factors related to the roadways and health (i.e., *Constraints/Motivators*) are primary considerations.

CLUSTER 3 – How Do I Feel Today?

Cluster 3 was defined by their unique responses to Scenarios 1.2 and 2.2.

In Scenario 1.2, individuals are faced with a choice between a mid-level instrumental need in A (medical appointment for knee pain) and a high-level instrumental need in B (need most important medication).

All individuals in Cluster 3 chose to drive in A (knee appointment). Their reasons for driving appeared to be emotionally driven, for example they highlighted feelings of joy in A versus sadness and depression in B. Two individuals mentioned that it would be fun to drive the new car.

Scenario 2.2 describes a choice between a medium-level instrumental need in A (almost out of vegetables) and a high-level instrumental need in B (no food in the house). As shown in Figure 17, it is a weaker contributor to the cluster selection.

All participants in Cluster 3 chose A even though the reason to drive was less compelling. In all cases the participant said they would either drive in both A and B or in neither, so their choice between the two was forced. Those who said they would not drive in either case talked about the impact of family criticism in A and poor visibility because of heavy rain and poor car windows in B. When pushed, they decided poor visibility was a more immediate deterrent and they selected A. For those who said they would drive in both, their final choice was made more from a perspective of reasons *not* to drive in B, mainly the heavy rain in combination with poor car windows (again, visibility). One woman selected A because she would enjoy driving a new car. One participant refused to make a choice and insisted there was no reason not to drive in either.

Cluster analysis revealed that this cluster tends to be male, older, and have the lowest habit strength for driving. Tendencies noted in the participants' survey data revealed individuals in this cluster were more likely to live alone and use transit for half or more of their trips. They rate their health as very good but do not consider themselves healthier than others their age. They report often being tired but say they are not limited in climbing 3 flights of stairs or opening a jar of pickles. They avoid driving in the dark, rush hour, and bad weather. Three of the seven individuals in this cluster has lightly bumped the car within the past 6 months.

Case Study for Cluster 3

Brian is a 79-year-old retired English teacher who lives in an apartment and cares for his wife who has Alzheimer's. Brian has macular degeneration and at the time of the study also had a bruised eye so used a magnifier to read some of the print material. He also suffers from Crohn's, arthritis, and a sleep disorder. He rated his own health as "a bit less healthy" than others and said he is rarely "full of pep and energy".

Because of his wife's illness, Brian is responsible for all of the instrumental tasks of daily living. He is able to walk to some stores but with his advanced age he is not able to carry a lot so needs his car to drive. He also needs to drive his wife to a daycare center a few days a week. He drives 4 days a week for a total of 4 hours, but also uses transit for about half of the trips he makes away from the apartment. Each week he drives to Surrey to play bridge with friends.

Brian's SRHI was 29, in the Low habit category. He rates his driving skills as "good" and is "a little confident" with his driving. However, he never drives when it is dark and avoids backing up, rush hour, and bad weather. Within the past 6 months he has lightly bumped into something while driving 3 or more times.

During the card sorting task, Brian sorted the photos into 10 piles – he described 7 of these piles as things he would be uncomfortable with, things he would avoid, times when he would hesitate to drive, and times he would drive only if he absolutely had to. In the scenario choices, knowing the route was a strong factor in his decisions. Health information was disregarded, including the doctor's warnings. Brian explained that he would forego a trip if he felt uncomfortable about driving, regardless of the reason. Instead, he would take transit, walk, or take a taxi.

Family statements that would have a high influence on Brian included statements that he was competent to drive. Statements about giving up driving had very low influence as did statements about how to modify his driving. For the latter, Brian said, "*I don't drive unless I need to. The roads don't make a difference,"* and *"I am already managing these. I feel I am good at judging myself & correcting things."*

Brian said that when he needs to go somewhere, he considers primarily his familiarity with the location and route, the weather, and traffic congestion; alternatives to driving (*Constraints/Motivators*) including public transit, walking and occasionally taxi, are also major factors considered in his decisions. Feelings of comfort/confidence (*Motivators)* that stem from his self-evaluation of skills within the specific driving task play a key role in Brian's decisions.

Summary

Cluster Analysis proved to be a useful tool in exploring whether distinct groups of older drivers can be identified based on their stated choice preferences. Results were combined with information collected by other methods to define three distinct categories of driving decision-making styles.

Cluster 1, labelled **Relationships Rule**, is defined by individuals who use primarily *Motivator* types of information in their decisions to drive, especially intrapersonal and goal motivators. This group tends to be female, median age, and have a high habit strength for driving.

Cluster 2, labelled **I'll Drive If I Have To**, is defined by individuals who rely somewhat on other types of transportation such as transit or rides from others. As a consequence, (or possibly a reason), their driving skills are weaker. When they do drive they use mainly *Constraints/Motivators* types of information in their driving decisions, especially environmental information such as weather, traffic, and distance. Members of this cluster tend to be younger females with medium habit for driving.

Cluster 3, labelled **How Do I Feel Today?** is defined by being older males with low habit strength for driving. They have poorer health, drive less, and have decreased skills as evidenced by their higher number of minor collisions. This group tends to use a higher number of information items in their decisions and include all types of information including *Constraints/Motivators* (alternatives to driving, driving environment), and *Motivators* (perceived abilities, confidence).

Choices by Scenarios

The results presented above summarize the analysis of decision choices undertaken to define groups of individuals with similar decision-making preferences. In conducting the research, each decision scenario presented to the participants had different combinations of items and characteristics, and the participants responded accordingly. To aid in fully understanding how participants responded, the following sections provide descriptive information on the scenarios, as well as brief summaries of the participants' key responses. Analysis by gender and habit strength is also included.

Scenario 1.1

This scenario presented low level (going for a regular blood checkup) and high level (have run out of important medication) motivation to travel. These represent perceived instrumental medical need.

In this scenario, the critical trade-offs were causing a recent rear-end collision (A) and running out of an important prescription (B). In total, 61% chose B, mainly because they felt it was worth risking other factors to get the prescription filled. In B, the main limiting factors were neck arthritis and travelling to an unfamiliar place.

Participants with low habit strength (67% of Low Habit) were more likely to choose scenario A indicating they were more affected by the recent rear-end crash than those with High (50%) or Medium (22%) habit (χ^2=4.675, p=.097).

There was no difference between men and women.

Table 8 Scenario 1.1

	Scenario A	Scenario B
Medical Need	Regular blood check	Important medication
Transit Available	No transit	Bus is close
Route	1 mile	New place
Ego	Feeling your age	Totally capable
Traffic	Rush hour	Late morning
Chronic Health	Feel healthy	Neck arthritis
Objective Skill	Recently rear-ended someone	No crashes
Acute Health	Recovering from a cold	Healthy
Weather	Sunny	Light rain

Scenario 1.2

This scenario presented medium level (medical appointment for a sore knee) and high level (have run out of important medication) motivation to travel. These represent perceived instrumental medical need.

In this scenario, both options included poor acute health but option B also included a vehicle with poor visibility and travel to an unknown location. Two thirds of participants chose option B. Women (75%) were more likely than men (55%) to choose B but the difference was not statistically significant (p=0.301). The main reason for choosing this option was that participants considered it more important to get medication than to attend an appointment for knee pain. Most said they could suffer through the pain for a couple of weeks if they had to. For some of those who chose option A, they noted that it might be unsafe to drive if they had not taken the important medication, or that there were no alternatives to driving in A whereas their daughter was available to drive to get the prescription.

In this scenario, 83% of Low Habit individuals chose B compared to 67% of High and 61% of Medium Habit participants suggesting Low Habit individuals may place more weight on health information, however the difference did not reach statistical significance.

Table 9. Scenario 1.2

	Scenario A	Scenario B
Medical Need	Medical appointment	Important medication
Alternate transport	Son won't drive	Daughter will drive
Route	1 mile	New place
Vehicle	New car	Poor car windows
Traffic	Sunday morning	Late morning
Acute Health	Flu symptoms	Recovering from a cold
Subjective Skill	As good as others	Excellent driver
Mental Health	Optimistic	Sad and depressed
Weather	Light rain	Sunny

Scenario 2.1

This scenario presented low level (shopping for shoes) and high level (there is no food in the house) motivation to travel. These represent perceived instrumental ADL need.

In this scenario, A presents serious health issues, a recent crash, and a doctor's warning. Most participants immediately said they would not drive and some declared no-one in this condition should be driving. They also noted that shopping for shoes was a low priority. Almost all participants chose B. Only 3 individuals (2 men and 1 woman) with Medium habit chose A. They noted that shortness of breath does not necessarily affect driving and there could have been a good reason for the rear-ender. They also noted the doctor just issued a warning and did not say they must stop driving now.

Table 10. Scenario 2.1

	Scenario A	Scenario B
Instrumental Need	Shoe shopping	Have no food
Transit Available	Bus is close	No transit
Route	Across town, familiar	1 mile
Alternate transport	Friend will drive	Son won't drive
Traffic	Rush hour	Sunday morning
Acute Health	Shortness of breath	Neck arthritis
Objective Skill	Recently rear-ended someone	No crashes
Interpersonal	Doctor warning	Doctor not concerned
Weather	Sunny	Heavy rain

Scenario 2.2

This scenario presented medium level (have run out of vegetables) and high level (there is no food in the house) motivation to travel. These represent perceived instrumental ADL need.

In this scenario, the critical trade-offs were the family criticism in A and having no food in the house in B. The heavy rain in B was noted by only a few participants.

Three quarters of the participants chose B. There were 2 participants with High driving habit that would not choose – they insisted they would drive in both. There was no difference between men and women, or between habit groups.

Table 11. Scenario 2.2

	Scenario A	Scenario B
Instrumental Need	Out of vegetables	Have no food
Vehicle	New car	Poor car windows
Route	Across town	1 mile
Alternate transport	Son won't drive	Friend will drive
Traffic	Rush hour	Late morning
Acute Health	Recovering from a cold	Feel healthy
Subjective Skill	Excellent driver	Good driver
Interpersonal	Family has criticized	Family has not criticized
Weather	Sunny	Heavy rain

Scenario 3.1

This scenario presented low level (regular coffee club meeting) and high level (rare visit with an old friend) motivation to travel. These represent perceived social need.

In this scenario, two social situations were depicted. For most, visiting a friend whom they rarely see (B) was the more compelling reason for a trip. However, B included a bad car battery while A included criticism from family, a recent near crash, and neck arthritis.

In total, most (83%) of the participants chose B, mainly because of the near-crash and family criticism in combination with the less important reason to go. All of the participants said the battery would not be a big problem because they would call BCAA. However, 30% of men (but no women) chose A. These individuals were enticed by driving the new vehicle, said others' criticism of their driving didn't matter, or that the near-collision was probably the pedestrian's fault for wearing black.

Those who chose A, with the new vehicle, were most likely to be High habit (33% of High Habit individuals) than low (20%) or medium habit (6%) suggesting individuals with

high habit for driving may be more emotionally attached to cars and driving, and place more weight on the experience of driving than others.

Table 12. Scenario 3.1

	Scenario A	Scenario B
Social Need	Regular coffee club	Rare friend visit
Alternate transport	Daughter will drive	Son won't drive
Route	New place	Across town, familiar
Vehicle	New car	Battery problems
Traffic	Rush hour	Late morning
Chronic Health	Neck arthritis	Healthy
Objective Skill	Almost hit a pedestrian	No crashes
Interpersonal	Family has criticized	Family has not criticized
Weather	Heavy rain	Light rain

Scenario 3.2

This scenario presented medium level (connecting with friends at a festival) and high level (rare visit with an old friend) motivation to travel. These represent perceived social need.

In this scenario, many of the participants were eager to use the free bus/taxi coupon to attend the festival (A) so declared they would not drive. Some added that parking and traffic would be an issue so a taxi would be a better way to get there. However, about half (57%) thought it was much more important to visit a friend they had not seen for a long time, so chose B. They were not concerned about travelling to a new place because GPS was available. They also rationalized that although the doctor had warned about driving, option B also said "You are totally capable". Furthermore, they noted it was Sunday morning so traffic would be light and the risk reduced. Taking the bus was not considered a reliable option on a Sunday.

In this scenario, 60% of Low Habit individuals chose A compared to 42% of High Habit and 39% of Medium Habit participants suggesting Low Habit individuals place less weight on the advice of their doctors (not statistically significant), possibly because they were aware of their medical conditions and had already reduced their driving. There was no difference between men & women.

Table 13. Scenario 3.2

	Scenario A	Scenario B
Social Need	Festival in the park	Rare friend visit
Transit Available	Free bus/taxi coupon	Bus is close
Route	Across town, familiar	New place
Ego	Feeling your age	Totally capable
Traffic	Late morning	Sunday morning
Mental Health	Sad and depressed	Worried
Subjective Skill	Excellent driver	Good driver
Interpersonal	Doctor not concerned	Doctor warning
Weather	Sunny	Light rain

Summary

This task analysis revealed that individuals may use the same information differently in making a decision about whether or not to drive. Additionally, types of information and how it was used varied across individuals with different SRHI habit scores.

For all scenarios, choice differences were observed with habit strength but not always between genders. Participants in the Low Habit group tended to put more emphasis on health information including the need to get an important prescription filled, not feeling well, and comments from their doctor. They were also more likely to consider information about their driving skills (a recent rear-end crash). Women seemed to put more emphasis on the reason for a trip, especially if it involved social interaction.

Participants with high habit scores were more likely to disregard comments made by others about their driving and seemed to be more enticed by driving a new vehicle. They also had more difficulty making a choice between options, sometimes refusing to choose and insisting that they would drive in both.

7.4. Influence of Others' Comments

The context within which older drivers make decisions includes interpersonal items such as the opinions of family and friends, social capital, and expectations of others. In the Older Driver Decision Components Framework II, these items are considered *Context* factors. The influence of comments made by others on older drivers was explored using a statement sorting task. Participants were asked to sort four categories of statements according to how much influence the statements would have on them. The four categories included statements to encourage them to: 1) continue driving; 2) modify their driving; 3) decrease their driving; and 4) stop driving. Participants nominated one close family member or friend, and imagined that person was making the statements.

Included within the context of an elder's decision may be the influence of comments that others make about their driving. These comments may modify the beliefs and attitudes that drivers have about the physical driving environment, evaluations of other drivers, and evaluations of themselves. Since research in other areas has demonstrated that elders are most likely to listen to others with whom they have a close relationship (D'Ambrosio, Coughlin, Mohyde, et al., 2007), participants were asked to think of a close nominated person in completing this part of the study.

In total, about half of the participants nominated a spouse (Table 14). Women were less likely to nominate a spouse, and this was likely influenced by being single and living alone. Four women and two men nominated a friend rather than a family member, primarily because they did not have family who ever observed their driving. Average MIRS Relationship scores were not different for nominated spouses compared to other relatives/friends, or for husbands compared to wives.

Table 14. Nominated persons for statement rating task

Nominated Person	Men	Women	Mean MIRS-A score
Wife	**15**	**--**	**111**
Husband	**--**	**7**	**116**
Son	**1**	**1**	**106**
Grandson		**1**	**102**
Daughter	**2**	**2**	**123**
Sister-in-law		**1**	**72**
Friend	**2**	**4**	**117**
Ex-Wife	**1**	**--**	**78**

7.4.1. Interviews

All participants said their nominated person was “a good driver” although in a few instances the participant said the nominated person drove faster or more aggressively.

When asked about comments that the nominated person had said about their driving, the vast majority could not recall many, if any, comments. Comments that were recalled reflected in-the-moment criticisms such as speed (e.g., you could go faster/slower) or direction of travel (e.g., you missed the turn). None recalled having a discussion about declining driving skills but a few said others had commented that they were a good driver.

The paucity of information extracted during the interviews suggest open-ended questioning is not a suitable method for examining this issue. It is possible participants were unable to spontaneously recall comments made about their driving, maybe because they did not have much influence and so were soon forgotten. Alternately, they may have been unwilling to recount negative comments for reasons of social acceptability, but given the candidness with which participants in this research responded to other parts of this research, this explanation seems less likely.

7.4.2. Statement Sort

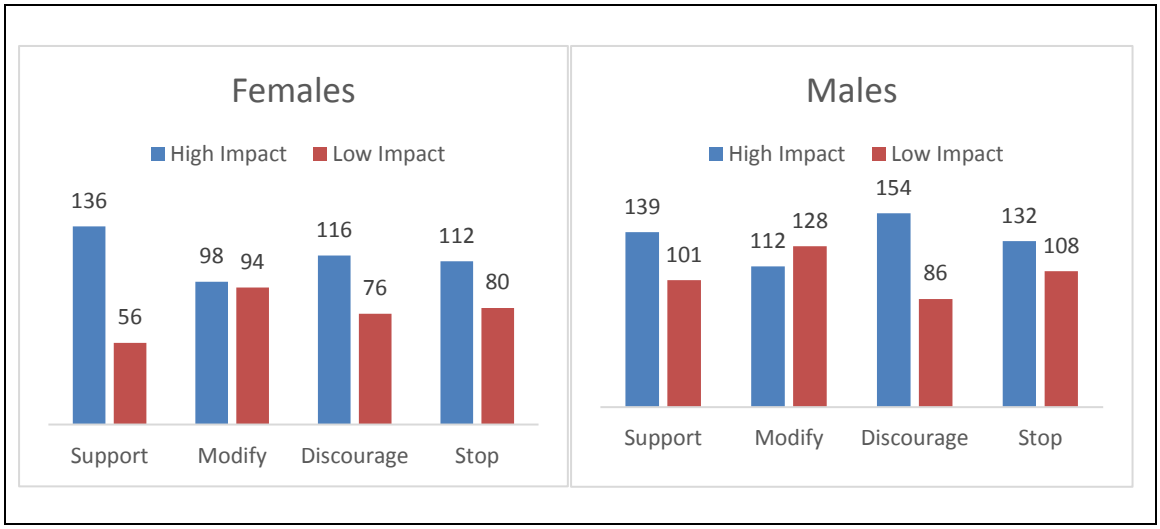
Participants were presented with 192 statements to rate according to the level of influence they thought the statements would have on them. Participants were able to complete this task with little difficulty. In a few instances the statements were not relevant, for instance, there were 2 statements that referred to grandchildren that were not relevant to participants without grandchildren. In these instances, the participants placed the statements at the *No influence* end of the scale.

Some participants expressed discomfort with some of the statements, declaring "*My [nominated person] would never say these things"*. They found placing these statements on the scale difficult because they could not imagine anyone saying these things to them. Most often they placed these items at the low influence end of the scale.

7.4.3. Number of Impact Statements

Men were most likely to listen to statements about how their driving skills were declining, while statements about how they should modify their driving were somewhat more likely to be ignored. Women were more likely than men to be influenced by statements affirming that they were good drivers, but similar to men, they also paid attention to comments about their declining skills and to comments aimed at prompting them to give up driving (Figure 27).

Figure 27. Impact of the four categories of family statements, by gender



Polarization of Influence

There were several participants who said at least 10 of the 12 statements in a category would have a strong influence, or alternately no influence, on them. Many of these participants placed all or almost all of the statements in either the highest or lowest influence category (Figure 28). Striking differences were seen between men and women, wherein women (75%) were much more likely than men (35%) to say the statements had either a lot of influence on them or no influence.

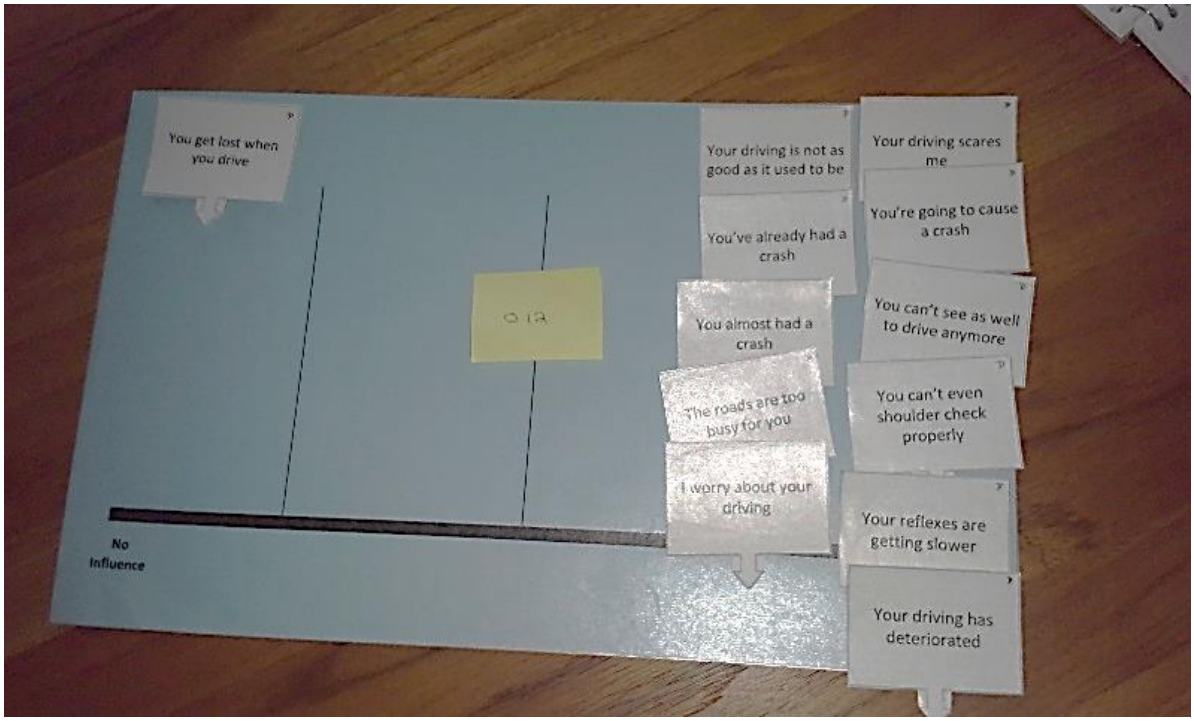


Figure 28. Example of polarized statement sorting

Instances where individuals placed at least 10 of the 12 statements in at one end of the scale were considered "polarized". Participants were selected if they polarized their responses in at least two of the four categories of statements. Two groups were created reflecting comments made by these polarized individuals:

1) *I don't care about others' opinions*
2) *You have to listen to your family*

Only 5 men (25%) met the criteria for group membership; the remaining men distributed the statements more evenly across the influence scale. Three men scored high for influence in more than one category of statements and were classified into the group, "*You have to listen to your family"*. Two men scored low for influence in more than one category and were classified into the group, "*I don't care about others' opinions".* Additionally, 3 men scored high in one category as well as low in one category reflecting an overlap between groups (Figure 29).

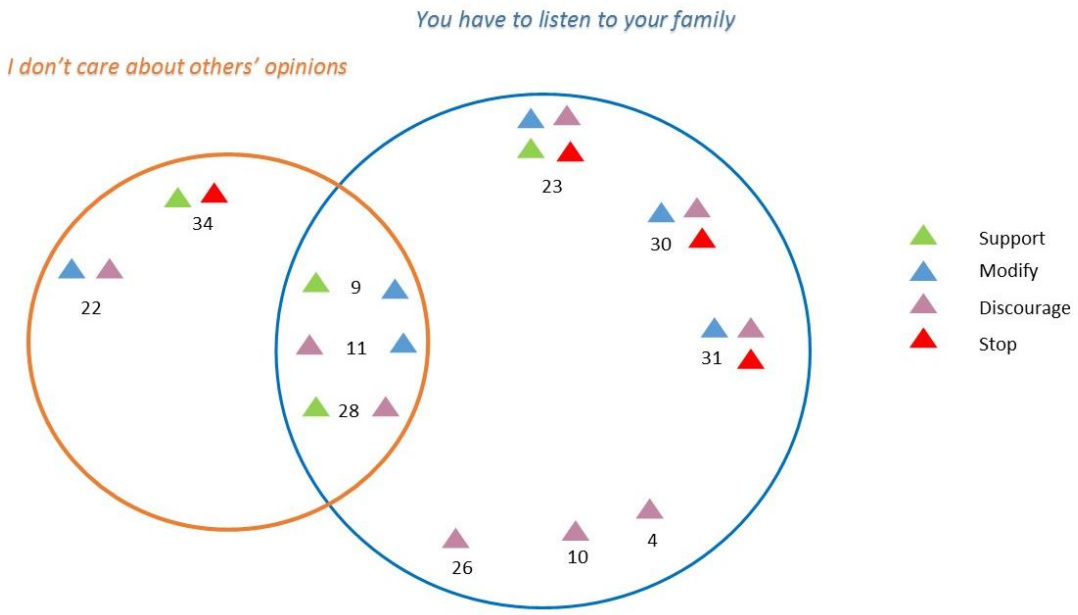


Figure 29. Males, High, Low, and Mixed Influence of Family Statements

In contrast to the few polarized men, almost all of the women had strong bias towards either being largely influenced by (n=8) or ignoring (n=3) the comments of others. Two women were strongly polarized to be influenced only by positive comments about their driving, ignoring all other comments. Only one woman did not show any polarization (Figure 30).

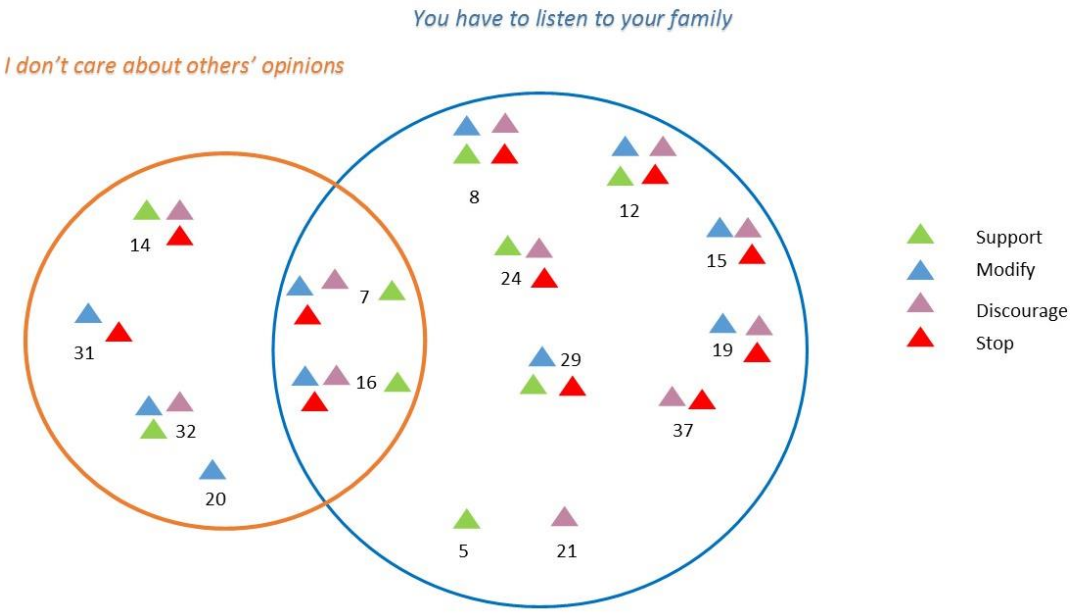


Figure 30. Females, High, Low, and Mixed Influence of Family Statements

Polarization by Cluster

Examination of the data by the clusters developed in Section 6.2.2.1 showed some interesting trends. In general, the proportion of polarized individuals varied across the clusters, with the lowest proportion in Cluster 1 and the highest in Cluster 3 (Table 15). This difference did not appear to be an artifact of gender since the proportion of males and females in the three clusters were approximately equal within each cluster and the same across clusters.

Cluster 1 had the lowest proportion of individuals that could be categorized into the, "*You have to listen to your family* group" (27%) although there were more in this category than in the alternate categories. Cluster 2 had the same proportion but an additional 27% who were in the, "*I don't care about others' opinions group".* Cluster 3 had the highest proportion (50%) of individuals in the, "*You have to listen to your family"* group; the remaining 50% said they would be highly influenced by some types of comments but would completely ignore others. In other words, individuals in Cluster 3 had strong and

sometimes contrasting opinions about the level of influence driving comments would have on them.

Table 15. Proportion of Individuals in Polarization Groups, by Cluster

	Cluster 1	Cluster 2	Cluster 3
You have to listen to your family	27%	27%	50%
I don't care about others' opinions	9%	27%	0
Mixed	0	9%	50%
Not Polarized	64%	37%	0%

Summary

In this sample of older drivers, statements supporting continued driving and statements aimed at encouraging them to limit their driving were believed to have more influence than statements that they should stop driving, or especially statements of how to change their driving habits. Differences between genders were noted, with women being more strongly polarized between *"You have to listen to your family"* and *"I don't care about others' opinions"*. Differences were also seen across clusters that were consistent with other characteristics defining the clusters. Cluster 1 (**Relationships Rule**), with the highest driving habit scores and social motivation to drive, were more likely to take the *"listen to your family"* attitude. Cluster 2 (**I'll Drive If I Have To**), with lower driving habit, had equal proportions of statements that they considered and ignored. Comments about driving had the greatest impact on Cluster 3 (**How Do I Feel Today?**), composed of individuals with the weakest habit and driving skills.

7.4.4. Participant Comments on Statement Sorting

After each sorting task was completed, participants were asked to explain their choices. Specifically, they were asked to describe reasons why they placed items in

different categories of influence, and what type of influence the statements would have on them. For example, participants were prompted by asking, “Could you explain to me why these statement would have more influence on you than these other statements?” and, “What would your reaction be to these statements?”

Overall, participants said they would be influenced by most of the statements presented to them. The predominant response was that they would “*pay attention to*” or “*consider”* the comments. When asked to clarify what this meant, they said they would “*think about”* what the family had said and “*be more aware”* of how they were driving. This included making sure they were shoulder checking, being more aware of pedestrians and vehicles, and controlling their speed.

When asked about how they would feel when others commented on their driving, participants said they would be ‘s*urprised*”, ‘s*hocked*”, “*upset*”, “*hurt*”, and sometimes insulted. Most denied that they would be angry with the other person whom they believed would be primarily acting out of concern for their (the elder’s) safety. They stated that they would not take the comments personally. On the other hand, a few participants (both men and women) became indignant with an “*It’s none of their business, I make my own decisions”* attitude.

A common theme was that the comments would initiate a discussion. Participants would ask for clarification about why the other person was saying these things. Almost all of the participants agreed that they would need concrete examples to support the statements, and that there would need to be several examples of the driving behaviour being critiqued. Several participants said they would seek verification from others about their driving, primarily a doctor who could comment on their physical and/or mental abilities, a driving instructor, or friends. However, in response to some of the stronger statements in the Decrease Driving and Stop Driving groups, some men and women said they would accept the criticisms at face value and stop driving.

One interesting outcome of the study was that several participants found that the sorting task made them more aware about how others evaluate their driving. They had not thought of many of the comments before. Several said they would make a point of asking others for feedback on their driving with the intention of improving their driving habits,

reduce their driving risk, and continue driving longer. They did not feel that they would respond any differently to another person making the comments, as long as they had a good relationship and thought the individual knew enough about how to evaluate driving.

Support Driving

Supportive driving statements were based mainly on *Context information* of the Older Driver Decision Components Framework model. They related to the elder driver's skills and abilities, and on societal norms and expectations, in a positive way.

Participants agreed the statements in this group were positive and supportive about their driving and in many cases affirmed their own beliefs: *"These are all positive. She's backing up what I think of my driving."* The majority of participants said almost all of the statements would have a high influence on them. The exceptions were statements referring to age, and statements comparing them with other drivers (Table 16).

Table 16. Proportion of participants rating Support Driving statements as High Influence

SUPPORT DRIVING STATEMENTS	HIGH INFLUENCE (%)
I feel safe driving with you	81
Would you please pick up the kids in your car	75
I prefer that you drive	69
You have a good driving record	67
There's nothing wrong with your driving	67
You're a great driver!	64
You should not give up driving	64
You can drive there	61
You're a better driver than most people	58
You're as good a driver as anyone	56
I don't think your age has anything to do with your driving ability	47
You're a way better driver than ____	39

Some women implied that positive comments would improve their driving by reducing anxiety. One woman explained, "*All of these are compliments, make you feel good. It shows their confidence in your driving. Makes you feel more confident, relaxed."* Another agreed, *"These are positive feedback, reinforce my knowledge that I am a good driver. If a person feels safe with me, I am more relaxed."*

For some, positive statements encouraged more driving. This was especially true among women whereas men were more likely to assert that the compliments would not change their driving style or the amount of driving they do. Comments from women included, *"These are very positive, telling me my driving is OK. Encourages me to keep driving",* and *"These would influence me to continue driving as long as I can."* Only one man, who has some significant health problems, said, *"Anything positive makes me feel good. I would be somewhat more likely to drive."*

Others considered the statements to be just unnecessary flattery. They were confident about their abilities and did not need to be told. As one man said, *"I'm conceited about my driving so statements of support don't influence me."*

Both men and women indicated they did not appreciate statements that compared them to other drivers, and most said they would ignore them. One man expressed, *"Better than who? I know other drivers and I don't like their driving."* One woman agreed, *"It means nothing to compare me. I know I'm ok to drive right now,"* and another summed it up, *"Comparison is not enough to persuade me of anything. There is the question of the ability of the other person you are comparing to."*

Some men equated the positive statements with their driving safety*: "I would take these as a compliment, affirms I am safe"; "Feels safe, it's the opposite of telling me I should not be driving."*

Modify Driving

Statements aimed at encouraging the older driver to modify their driving were based on *Motivators* (skills and abilities) and *Constraints/Motivators* (driving environment,

health) of the Older Driver Decision Components Framework II. Items were presented in a negative way.

One half to two-thirds of participants rated most of the statements in this group as High Influence (Table 17). This was less than the proportion who gave a High Influence rating to the Supportive statements.

Four statements were not rated High Influence by the majority of participants. These statements included directions to drive slowly, not take long trips, take driving lessons, and drive only within the neighbourhood. This latter statement was particularly unpopular – most commented that if they could only drive around the block that would mean they were too frail to drive at all. Since they did not feel this was true, they said they would ignore the comment. A few voiced the opinion, "*Lessons won't help me at this age"*.

Comments about driving too fast or too slow were sometimes given a High Influence rating because participants said they would comply with the wishes of a passenger to make them feel more comfortable. On the other hand, for some, speed and distance of travel was considered the decision of the older driver.

Table 17. Proportion of participants rating Modify Driving statements as High Influence

MODIFY DRIVING STATEMENTS	HIGH INFLUENCE (%)
You drive too fast	67
You are driving too slowly	64
You need to get your eyes checked. You miss things.	64
You shouldn't drive at night	58
Avoid that busy intersection	58
Take the quiet route	56
You should not be driving on the highway	53
If you drive, I will help with reading the road signs	53
You'll be OK if you drive slowly	44
You shouldn't be taking long trips	44
You should consider taking some driving lessons	33
It's OK if you just drive around your neighbourhood	28

Many of the participants interpreted the directive statements about where and when to drive as criticism. For some, their reactions were strongly negative and suggested they felt insulted. They rated the statements as having low influence on them. Negative reactions included:

> *These are directive comments, telling me what to do. It puts my back up. [F]*
>
> *"Drive slowly" statement is patronizing. You poor thing, it implies you're disabled. [F]*
>
> *"Drive slowly?" Patronizing old bitch! These things are too personal so have no influence. [M]*
>
> *These mean nothing. They're opinions I don't accept. [F]*
>
> *I'm a very good driver & I don't need advice from her. Pain in the ass. I'd ignore her. [M]*

More positive reactions to some of the statements included:

> *These are giving me tips to improve me & reduce risk. [M]*
>
> *These are more practical – take the quiet route, avoid the busy intersection. I do these now. I would comply with these, they are sensible. [M]*
>
> *These are maybe helpful – the person might know a better route, read signs in a new area to help out. [F]*

In general, women seemed to be less offended by some of the statements. Several had the attitude expressed by one woman, *"These are pretty bad. If he says these, it must be true. I would consider these. He's saying I should change, restrict my driving."*

Some participants were especially concerned about the statement, "*You need to get your eyes checked, you miss things"*. They interpreted this statement as losing some of their cognitive abilities. One man explained, *"I'd be real worried if she said I need my eyes checked. This would mean I am missing things, problem with attention, not my eyes."* Another commented, *"Get my eyes checked means I'm missing things, maybe also memory loss."*

A few participants interpreted some of the statements as indications that they should not be driving at all. *"Drive only in the neighbourhood? Ooo, that's scary, should not be driving at all!"* and *"Driving too slow is a sign of impairment, so it is never ok if you can only drive slow,"* were comments made by men.

Decrease Driving

Statements aimed at encouraging the elder to decrease the amount of driving they do were based mainly on *Constraints/Motivators,* especially health, of the Older Driver Decision Components Framework II. They related to the elder driver's declines in personal resources including physical and cognitive abilities. *Motivators* (driving abilities) and *Context information* (interpersonal factors) were also included in the statements.

Almost all of the statements in this group were considered to have a High Influence on the majority of drivers (Table 18). The exception referred to getting lost while driving. Most of the participants said they do not get lost, at least not anymore, because they use GPS to help navigate. Those without GPS said they look up the location on the internet before starting out. Participants did not believe this statement was true so would ignore it.

Table 18 Proportion of participants rating Decrease Driving statements as High Influence

DECREASE DRIVING STATEMENTS	HIGH INFLUENCE (%)
Your reflexes are getting slower	81
Your driving scares me	75
Your driving has deteriorated	72
You can't see as well to drive anymore	69
I worry about your driving	67
Your driving is not as good as it used to be	61
You almost had a crash	58
You're going to cause a crash	58
You've already had a crash	56
You can't even shoulder check properly	53
The roads are too busy for you	50
You get lost when you drive	47

As the participants sorted the statements from this group, they recognized them as indicating that their nominated person thought their driving had become unsafe and that they probably should no longer be driving. Most of them were surprised by the statements and declared that no-one had ever said anything similar to them. In fact, some said their nominated person would never say such things because they were "not even close to that stage".

> I *know better than he does so these have less influence on me. I know how many crashes I've had; I shoulder check better than he does; I don't have GPS but I check a map ahead of time so I don't get lost. [F]*

Very few reacted angrily to the implication that their driving skills had declined:

> *You're going to cause a crash is nagging. You're deteriorating – more nagging. I make my own decisions about my driving. [M]*

> *I'd get angry, disagree with these. [M]*

However, most recognized that if their family said these things to them, it was because they were not adequately evaluating their own situation. Most said they would listen and take some action including talking to the doctor and stop driving:

> *These imply you are at a standard that has gone down. This is something new & she has noticed it, can measure it. It needs to be dealt with. [M]*
>
> *She knows me as a driver & is telling me, "Don't drive any more". It means it has deteriorated. Scary. I would listen, I would talk to my doctor, and my wife would talk to him also. [M]*
>
> *These would make me do something, I would consider not driving. I would want to know the cause of my bad driving. I shouldn't be on the road, it is a crash waiting to happen. I would stop & think not to drive. I would never not listen to any of these [F]*
>
> *You have to listen to others. Some don't listen because they're disillusioned about their driving. My friend wouldn't hold back on such comments about my driving. [F]*
>
> *If he noticed these I would listen. It means I'm deteriorating, shouldn't be driving, definitely. Just not safe – for me & for others. [F]*
>
> *I would take these very seriously. I would argue if there was no objective proof, e.g., "You're going to cause a crash". I would take lessons & get feedback from the instructor. Get a medical checkup. [M]*
>
> *He's noticing things. He's saying I should give up driving. I would accept it, consider stopping. I would not argue, I would believe him. I would just stop. I might go to the doctor. [M]*

Stop Driving

Statements seeking to stop the elder from driving were based mainly on *Motivators* of the Older Driver Decision Components Framework II. They appealed to emotions (intrapersonal factors), alternatives to driving, and vehicle issues in a negative way. Some

items drew on *Context information* (societal norms, legal), also presented in a negative way.

Only half of the statements elicited a High Influence rating from the majority of participants (Table 19). References to the safety of children had the greatest impact. Considering all statements in the study, the statement "*How would you feel if you hit a child?*" received the greatest number of High Influence ratings (83%). Participants indicated they would be highly influenced by direct comments about not driving, and by warnings that they are likely to cause a serious crash. Participants used emotional language such as "*horrific"* and "*devastating"* when talking about these types of statements.

Table 19. Proportion of participants rating Stop Driving statements as High Influence

STOP DRIVING STATEMENTS	HIGH INFLUENCE (%)
How would you feel if you hit a child?	83
I don't want you to drive your grandchildren	78
I don't want you to drive anymore	75
You should stop driving now	72
You're going to kill someone someday if you keep driving	72
Let me drive	67
You could take a taxi	50
The police will take away your license	50
I can drive you wherever you want to go	50
You should think about selling your car	39
People your age should not be driving	31
It is too expensive to keep your car	25

Some of the statements, particularly those referring to crashes and police, were interpreted as threats in attempts to belittle the participant into giving up driving. One man exclaimed, *"These are threats. You should tell them about their driving, specific things,*

evidence, not just use threats.", and a woman defended, *"Foolishness. Not worthy of paying attention to. Just supposition, I don't believe it, it's wild supposition."*

Statements about selling their car, that their car was too expensive, and that they should take a taxi were almost unanimously met with indignation, asserting that the vehicle cost was nobody else's business: "*My money is my own business", "It's my car, I'll sell it when I want".*

The statement, "*People your age should not be driving"* also had little impact on these participants. They often talked about how some elders, younger than themselves, were too feeble to drive while others drove well into old age. Some found the statement offensive: *"This is arrogant, people are all different", "Age is not a factor, we know older people who drive fine.", "Age is a ridiculous comment."*

Key Statements

As the participants were rating the statements, they were asked to choose two from each group that would have the most impact on them. The statements were chosen only from among those that they had already rated as having high influence. Statements chosen by at least one quarter of the participants are presented in Table 20.

Table 20. Highest influence statements (number of times chosen)

STATEMENT GROUP	KEY STATEMENTS
Support Driving	I feel safe driving with you. (15) I prefer that you drive. (11) Would you please pick up the kids in your car? (9)
Modify Driving	You need to get your eyes checked. You miss things. (12) You should not be driving on the highway. (9)
Decrease Driving	Your driving scares me. (13) You're going to cause a crash. (9)
Stop Driving	You're going to kill someone someday if you continue driving. (14) How would you feel if you hit a child? (13) I don't want you to drive your grandchildren. (12)

Overall, the key statements chosen by participants represented primarily *Context information,* especially Interpersonal. These included subjective appraisals such as feeling safe or afraid, contributing to family by driving grandchildren, and questions about the driver's skills and abilities. This seems to be in conflict with declarations made by participants that they would be most influenced by specific examples of driving difficulties, typically representing *Constraints/Motivators*.

Summary

Participants in this study agreed that many comments from close family or friends about their driving would at least make them think about their driving, and in fact, participation in the study already had that effect. They also agreed that in most cases they would ask for clarification as to why the family was saying those things, requesting specific examples. For the most part they would not be angry with the individual, but they would nonetheless be surprised and sometimes hurt. In a few cases, especially with regards to the cost of driving or when and where to drive, participants might become indignant that *"it is none of their business"* or "*I make those decisions"*. Comparisons of their driving with others were not well received.

Key statements of influence represented mainly *Context* information rather than *Constraints/Motivators* as expected. Despite participants' insistence that they would pay more attention to specific examples of their driving problems, they chose statements that appealed more to interpersonal aspects of driving. It is possible, however, that these types of statements would have the greatest impact on older drivers through initiating a discussion about driving with the other person.

7.4.5. Trends by Clusters

Analysis of decisions made by participants identified three groups that could be characterized according to decision-making styles. A key question in this research was whether differences in decision styles, and personal characteristics associated with the

individuals in those groups, were also correlated with participants' reactions to comments about their own driving.

Differences were seen in patterns of statement sorting across the three clusters identified in Section 6.2.2.1. In general, participants in Cluster 2 were least likely to be influenced by comments made by others. Cluster 2, labelled **I'll Drive If I Have To**, are more likely to use transit or other means of transportation. Since driving is less critical to them as a form of transportation, it is not surprising that statements about driving would have less influence – they may already feel confident in their decision-making abilities.

Participants in Cluster 3 were more likely than others to pay attention to comments that supported their driving or that suggested their driving skills were declining. Participants in Cluster 3, labelled **How Do I Feel Today?** tend to be older, have the lowest habit and highest transit use, and demonstrated a greater number of crashes within the past 6 months. It may be interpreted that participants in this cluster have doubts about their driving so look for statements that either confirm or refute these doubts.

Individuals in Cluster 1, labelled **Relationships Rule**, showed slightly more concern than other clusters over statements about modifying their driving and stopping driving (Table 21), although the differences are not significant. These individuals were strongly motivated to drive, especially for social reasons. It is therefore reasonable that individuals in this cluster would be anxious about statements that suggest their driving is less than adequate since that would threaten their ability to maintain social connections.

Table 21. Proportion of participants rating groups of statements as High Influence, by Cluster

Statement Group	Cluster 1 Relationships Rule	Cluster 2 I'll Drive If I Have To	Cluster 3 How Do I Feel Today?
Support Driving	65%	61%	71%
Modify Driving	57%	46%	54%
Decrease Driving	64%	55%	76%
Stop Driving	63%	55%	60%
Mean Proportion	**62%**	**54%**	**65%**

Support Driving, by Cluster

Participants from the three different clusters had different opinions about which supporting statements would have High Influence on them (Table 22). Most of the participants in Cluster 1 said they would be highly influenced by, *"You should not give up driving"* and *"There is nothing wrong with your driving"*. This is different from Cluster 2 and Cluster 3 where affirmations from others that they *"feel safe"* had high influence by virtually all participants in those groups. References to safety may be less important to individuals with high habit for driving because they already assume their driving is safe.

Most of the participants in Cluster 3 also said they would be highly influenced by declarations that they were a great driver, that others felt comfortable enough to prefer that they drive, and that their family had confidence enough to request they drive the grandchildren. Since drivers in Cluster 3 display more signs of declining skills, it is understandable that they would be more influenced by statements of support.

Table 22. Proportion of participants who rated Support statements as high influence

Support Driving Statements	Cluster 1 Relationships Rule	Cluster 2 I'll Drive If I Have To	Cluster 3 How Do I Feel Today?
You have a good driving record	73%	64%	71%
You're a better driver than most people	73%	45%	57%
I don't think your age has anything to do with your driving ability	45%	55%	57%
You're a great driver!	73%	45%	86%
I feel safe driving with you	73%	91%	100%
You can drive there	45%	73%	57%
You should not give up driving	82%	64%	71%
You're as good a driver as anyone	64%	55%	57%
You're a way better driver than ____	55%	27%	43%
There's nothing wrong with your driving	82%	64%	71%
Would you please pick up the kids in your car	64%	73%	86%
I prefer that you drive	55%	73%	100%
Mean Proportion	**65%**	**61%**	**71%**

Modify Driving, by Cluster

Statements made to encourage driving self-regulation were generally not rated as highly influential as the supportive statements (Table 23). In particular, suggestions to rely on a passenger to read the road signs, take lessons, and drive only in the neighbourhood were ignored, especially by those in Cluster 2. In contrast, Cluster 1 participants who are more socially motivated to drive received the offer to read road signs quite happily. They considered this type of interaction with their passengers as "helpful" and perhaps considered it part of their social interaction.

The older, less physically capable drivers in Cluster 3 were most receptive to the suggestion about speed control. It is possible they recognized that driving too slow confirms they had decreased skill, and driving too fast could pose additional risk that does not match their skill level.

Table 23. Proportion of participants who rated Modify statements as high influence

Modify Driving Statements	Cluster 1 Relationships Rule	Cluster 2 I'll Drive If I Have To	Cluster 3 How Do I Feel Today?
You shouldn't drive at night	64%	55%	57%
You should not be driving on the highway	64%	55%	57%
Avoid that busy intersection	55%	45%	57%
You drive too fast	64%	64%	71%
Take the quiet route	64%	36%	43%
You are driving too slowly	73%	55%	71%
You'll be OK if you drive slowly	45%	45%	43%
If you drive, I will help with reading the road signs	73%	27%	57%
You need to get your eyes checked. You miss things.	64%	73%	43%
You should consider taking some driving lessons	36%	27%	57%
You shouldn't be taking long trips	55%	36%	43%
It's OK if you just drive around your neighbourhood	27%	27%	43%
Mean Proportion	**57%**	**45%**	**54%**

Decrease Driving, by Cluster

Participants in Cluster 3, who were less physically capable drivers than the others, paid considerably more attention to statements suggesting their skills had declined and they should reduce their driving (Table 24). This is not unexpected since they may be more sensitive to age-related declines.

Participants in Cluster 2 were especially not impressed by the statement *"You get lost when you drive"*, possibly because these individuals drive a limited number of places so likely know the routes well. Participants in the socially-connected Cluster 1 said they would be highly influenced by comments that *"Your driving scares me"*, demonstrating concern for the welfare of others. Individuals in this group may also be concerned that others would not drive with them if they felt scared.

Table 24. Proportion of participants who rated Decrease statements as high influence

Decrease Driving Statements	Cluster 1 Relationships Rule	Cluster 2 I'll Drive If I Have To	Cluster 3 How Do I Feel Today?
You get lost when you drive	45%	27%	71%
You can't even shoulder check properly	45%	45%	57%
You can't see as well to drive anymore	73%	64%	86%
You've already had a crash	55%	45%	86%
Your driving scares me	82%	55%	86%
You almost had a crash	64%	55%	71%
I worry about your driving	64%	64%	86%
Your driving is not as good as it used to be	64%	64%	71%
The roads are too busy for you	55%	55%	57%
You're going to cause a crash	64%	45%	71%
Your driving has deteriorated	73%	64%	86%
Your reflexes are getting slower	82%	73%	86%
Mean Proportion	**64%**	**55%**	**76%**

Stop Driving, by Cluster

Direct comments about not driving had similar overall influence across all clusters, but some individual statements had selective effects (Table 25). Direct commands to stop driving now had the highest impact on Cluster 3 participants, possibly because their own driving confidence was lower. Statements such as *"Let me drive"* had more influence on participants in Clusters 2 and 3 who already use transit or get rides from others. These individuals said they would be happy to let others drive.

More Cluster 1 participants said they would be highly influenced by the threat that police would take away their license, possibly because they have a stronger habit for driving so would be more profoundly affected by losing their license.

Table 25. Proportion of participants who rated Stop statements as high influence

Stop Driving Statements	Cluster 1 Relationships Rule	Cluster 2 I'll Drive If I Have To	Cluster 3 How Do I Feel Today?
You could take a taxi	55%	45%	57%
The police will take away your license	73%	36%	43%
Let me drive	64%	82%	86%
You should stop driving now	64%	64%	86%
It is too expensive to keep your car	55%	18%	0%
How would you feel if you hit a child?	82%	91%	86%
People your age should not be driving	36%	18%	29%
You should think about selling your car	55%	36%	29%
I don't want you to drive anymore	73%	73%	71%
I can drive you wherever you want to go	55%	55%	57%
You're going to kill someone someday if you keep driving	73%	64%	86%
I don't want you to drive your grandchildren	73%	73%	86%
Mean Proportion	**63%**	**55%**	**60%**

Summary

Examining the data across the three clusters defined in Section 6.2.2.1 showed some differences between the clusters in terms of overall impact of the statements. Additionally, individual items had varying impacts. In general, these impacts were consistent with other defining characteristics of the clusters.

Individuals in Cluster 1, labelled **"Relationships Rule"**, were more willing to allow others to help with reading road signs, were highly influenced by comments that *"Your driving scares me"*, and were more influenced by threats of losing their driver's license. These types of statements have a strong emotional component and are consistent with participants' social motivation and high habit for driving.

Individuals in Cluster 2, labelled "**I'll Drive If I Have To"** were less affected by family statements in general. This possibly reflects the fact that they already use transit and get rides from others, and are most likely to drive only when they feel the conditions are manageable.

Individuals in Cluster 3, labelled **"How Do I Feel Today?"** are older and show evidence of decreased driving abilities. Most individuals in this group were highly influenced by comments that either support their continued driving or confirm that their driving skills had declined. This is consistent with lower confidence in their driving, which would increase the salience of others' evaluations.

Chapter 8. **DISCUSSION**

With advanced age, many individuals experience declines in physical and/or cognitive abilities that make driving a vehicle more difficult. Such changes can increase the aging individual's risk of causing a crash. We know that with advanced age many elders begin to restrict the amount and type of driving they do (Donorfio et al., 2008; Molnar, Eby, Zhang et al., 2015). However, relatively little is known about how individuals arrive at such decisions. The main aims of this research were to explore how older adults make day-to-day decisions about their driving, especially about whether or not to drive, and the influence that families have on those decisions. The methods used in this research produced a rich collection of information about how elders approach decisions about driving, how they evaluate driving-relevant information, how they respond to others, and what types of decisions they make.

This research represents an exploratory study into older driver decision making, including what types of information they use in their decisions, and how context affects their decision processes. Results of this research supported the development of preliminary models to describe the decision processes, and a framework for understanding the various components in the decision process. It is hoped that this work will add important knowledge for developing policies and programs that support safe transportation for an aging population.

In 2007, the Rand Institute for Civil Justice (Loughran, Seabury & Zakaras, 2007) developed a policy paper on older drivers in which they stated:

> *There are two reasons for the public to be concerned about older drivers: (1) the potential danger they pose to other drivers and passengers and (2) the danger they pose to themselves. Relatively stringent licensing policies for older drivers are more easily justified by the first concern than the second. The reason is that, as a society, we generally allow individuals more freedom to make choices that impose risks on themselves than we allow them to make choices that impose risks on others. Policy can be paternalistic, too, but usually more so when there is good reason to believe that individuals are making poorly informed choices about risk.*

The importance of appropriate driver decision-making amongst older individuals was acknowledged in the statement above as a major consideration in developing policy decisions such as directly limiting the amount of driving older individuals would be permitted (e.g., through restricting licenses), or raising the cost of driving for elders such that they would have less incentive to drive (e.g., through higher insurance premiums). Enactment of policies such as these could, in turn, affect other policies including more intensive screening for older drivers at a cost to the public, or perhaps to the drivers themselves. Further, enhanced screening or testing would require policies concerning who should be tested, what is to be tested, or who would be responsible for the testing. Alternately, policies could shift away from the driver to the roadway and vehicle safety features that could compensate for poorer older driver decision-making. This last point is a direction endorsed by the UK's RoSPA (Royal Society for the Prevention of Accidents) in their Older Driver Policy Statement (RoSPA. 2010). Their policy statement outlines 13 additional directions, two of which contain elements that are addressed in the current research:

> *Research which helps develop better understanding of the link between self-regulation and crash risk, and how to help drivers to match the environments that they drive in to their condition would be a valuable contribution to this area.*

and

> *Families who are concerned about the driving standards of elderly relatives may also currently struggle to find appropriate advice, and this need must be addressed.*

Strong theories and models improve the design and results of research. Early in undertaking this study it became evident that applicable models were lacking. The current research, therefore, included developing and refining a model of older driver decision-making that could frame a structure and common language for future studies in this area. This thesis highlights key concepts and decision components identified by the participants establishing a starting point for future research. Additional in-depth qualitative data were collected during the course of this study that could be used in future to further elucidate the findings presented here.

This thesis addresses major gaps in the research on driver self-regulation, on decision processes employed by aging drivers, and how these processes differ across individual characteristics. Results of the study are used to develop and refine an **Older Driver Decision Components Framework** that supports the existing literature on self-regulation, but also provide a new direction for research on aging and transportation and form a basis for understanding decision-making amongst older drivers. This new direction goes beyond the current checklists of self-regulatory behaviours, to understanding how aging drivers go about deciding to change their driving patterns. Refinement of our knowledge about how elders make decisions involving their driving environment and their skills may be used to better understand how they adjust their transportation needs (and desires) to their age-related changes. In turn, this knowledge may be used to inform policies and design programs to support their decision-making.

A scan of the literature, to date, indicates there have been no studies that examine the processes involved in driver decision-making addressed in this study. We know that health conditions are associated with driving self-restrictions or cessation (Marshall & Man-Son-Hing, 2011), and that negative attitudes towards driving – such as driving comfort, self-evaluations of their own driving abilities, and negative feedback of others – may mediate these relationships (Jouk, Sukhawathanakul, Tuokko et al., 2016; Tuokko, Sukhawathanakul, Walzak et al., 2016). However, the processes through which health and attitudes affect whether an individual will drive have not been elucidated. The current study begins to increase our knowledge about factors that affect how individuals select and incorporate different types of information from various sources into their decision-making, and how this actually affects the decisions that are made. Further research focused on a deeper dive into how these key factors affect information use could enhance our understanding.

This research goes beyond traditional research designs in using an integrative mixed methods approach (Castro, Kellison, Boyd & Kopak, 2010) by combining qualitative and quantitative methods in the same stage. Using a convenience sample of 37 urban dwelling seniors, age 70-96 years, it begins with exploring how participants experience driving to gain knowledge about elements that are important to elders as they evaluate their abilities, desires and needs in relation to the demands of the driving environment

(Section 7.2). Next (Section 7.3), the types and amounts of information used in decisions are identified and explored. Analysis reveals three clusters of participants based on their stated preferences for driving to attain a goal. This is followed, in Section 7.4, by an investigation into how elders make sense of the comments made by family members and friends and the influence they may have on older drivers and their decisions. Results are examined by gender and decision-making styles.

Throughout this study, participants were challenged to reflect on their own driving and about what driving meant to them in order to complete the tasks. This produced a rich amount of information about how the participants experience driving, how they interpret and attach meaning to them, and the emotions they feel while thinking about, planning, deciding, and performing the driving task. The study also produced a wealth of information about how context, such as changes in personal resources and the driving environment, affect thoughts about driving and how it influences the experience of driving. Some of this data is presented to support development of the theoretical models, but in-depth analyses is reserved for later.

8.1. Developing Models of Driving Decision-Making

Very little information was found in the literature on older driver decision-making that could be used to guide this research into elders' decisions about whether or not to drive. The literature on older drivers offers considerable evidence on changes in crash risk associated with advanced age and illness (Charlton, Koppel, Odell et al., 2010), and on types of older driver self-regulation (Molnar, Eby, Zhang et al., 2015). However, no evidence was found on how elders choose to drive versus not to drive, nor on what factors influence those decisions in the moment. In particular, very little evidence was found on the amount and types of information used by older drivers in their decision-making, or on how they integrate this information into their decisions.

Existing models of driving are inadequate in explaining how older adults make driving decisions that may represent self-regulation in response to declining personal resources. Since theoretical frameworks and models are helpful in guiding research and interpreting results, the starting point for this study was the development of a working

prototype framework for older driver decision-making. Results from the study were used to refine the prototype. Although a wealth of information about driving was collected from the participants, only the results that support development of the framework are highlighted here. Additional data analyses that add depth to our understanding may be carried out in future.

To guide the current research, three conceptual models were developed. In the first model, P-E fit (Lawton & Nahemow, 1973) was integrated with a model of Behavioural Decision Theory (Garling, Laitila & Westin, 1998) to develop a hypothetical model of their inter-relationship as applied to driving decision-making (Figure 2. Conceptual illustration of model relationships). This model recognizes the strong contribution that habit plays in driving behaviour, and acknowledges that a stimulus of sufficient importance is required to initiate deliberative or active decision-making. Consistent with the literature on age-related declines, the model illustrates how mismatches between the declining resources of the older driver and the demands of the driving environment can provide a trigger to active decision-making, and how habitual driving behaviour weakens with increasing resource-environment mismatches.

The second model development involved conceptualizing a **Driving Decision Process Model** (Figure 3) to describe passive (habitual) versus active decision-making. This model integrates the components of P-E fit as a context or decision frame, as outlined in Behavioural Decision Theory. This model illustrates that in making driving decisions, two significant pathways are possible: 1) passive decisions (i.e., habitual action) that lead directly from the goal being sought to the behaviour of driving; and 2) active decision-making wherein there is a change in the context (decision frame) that triggers awareness of a need to consider new information, leading ultimately to a deliberative driving decision.

Finally, the **Older Driver Decisions Components Framework** was developed to guide the exploration of the types of information elders use in their decisions, and how this information is used. In this framework, three major components were initially hypothesized: *Motivators*, *Constraints* and *Contextual Factors*. *Motivators* were conceptualized as items that prompt a need to drive; *Constraints* were conceptualized as items that could discourage driving; and *Contextual Factors* were conceptualized as items

that influence the perspective of the decision-maker. In keeping with Decision Theory, this model illustrates how the main pathway to the decision to drive is habitual, but at other times, the individual may actively incorporate items within each of the three main information components of the framework, in varying amounts, to consider in a decision about driving.

Results of the Decision Preferences portion of this research (Section 7.3.3) revealed that the initial **Decision Components Framework** did not accurately reflect how the participants in the study used information in their decisions. In particular, it was found that some items were used alternately as either constraints or motivators, depending on their state and on how these items interacted with other items. A revised model was constructed (Figure 14) reflecting this variability, and identifying the major components as *Motivators*, *Constraints/Motivators,* and *Context*. In the revised model, driving decision-making was illustrated as a sphere within which the individual appraises goal attainment versus risk by considering different types and amounts of information from some or all of these major components. The changeable use of *Constraints/Motivators* is seen as being influenced by the other components within the framework. Lack of consideration of *Constraints/Motivators* in a decision is seen as representing habitual action.

The varying use of *Constraints/Motivators* found in this research is consistent with current knowledge on decision-making in other domains. Rather than static decision processes which are repeatedly applied to different choice contexts, the conclusion drawn by Behavioural Decision Research is that individuals have a repertoire of decision strategies for solving decision problems (Bettman, Luce & Payne, 1998, p. 194). Well-practiced preferences appear to hold under conditions where the choice task is familiar or when the individual has experience with the various alternatives that are presented (Payne et al., 1993). However, in many instances it is argued that these conditions fail to apply, and preferences are instead constructed in response to the contextual effects which vary according to the properties of the choice task (Leung & Hensher, 2012). Kim and Trail (2010) agree that determining whether factors are used as constraints or motivators depends on the context. In a study of participation in sport activities, these authors found that a variety of contextual changes might flip a factor from being a constraint to being a motivator, and vice versa.

8.1.1. Enhancing Existing Models

Existing models of driving are inadequate in explaining how older adults make driving decisions that may represent self-regulation in response to declining personal resources. The Enabling Driving Competence model (Anstey et al., 2005) reflects the view that cognitive, sensory, and physical variables determine an individual's capacity, but that the individual's insight into one's driving capacity determines or mediates the choices that are made about driving behaviour and driving safety. However, this model is limited in that it does not include attitudes or social influences and does not address how the individual integrates different variables to determine behaviour. The Driving as an Everyday Competence (DEC) model (Lindstrom-Forneri et al, 2010) improves prior models by including contextual factors such as social, attitudinal, emotional and policy that are missing in Anstey's model. However, the DEC model also fails to explain the processes that link the components, or the relative importance of the components. The models developed in the current research address these deficiencies by including a broader range of variables and by describing the processes by which these variables are used by the individual.

The MOTRS model of older driver self-regulation, proposed by Wong and colleagues (2016), is the most relevant to the current study, especially since it focuses specifically on older driver self-regulation. Although the MOTRS model was not designed to explain decision-making, there are some consistencies between this model and the current research. The MOTRS model distinguishes between individual and environmental factors, consistent with P-E fit that was used to guide the current research. It describes how individual and environmental factors, together, influence driving. In the current research, the Conceptual Driving Decision Process Model also outlines the interaction of the individual (aging changes) and the environment (driving environment changes) in forming a decision frame. Both models recognize the contribution of psychosocial constructs: confidence and perceived behavioural control in the MOTRS; awareness, needs and wants in the Decision Process Model. However, the latter model describes the processes leading to driving behaviour through passive (habit) or active decision-making. In contrast, the MOTRS model describes factors that are specifically associated with and are believed (but not proven) to influence self-regulation.

Both the work of Wong and the current work note the differential impacts of various factors on driving behaviour. The MOTRS model describes how each variable can "simultaneously generate excitatory (i.e., positive) and inhibitory (i.e., negative) activation of the network," and "whether or not an older adult practices driving SR [self-regulation] is determined by a combination of excitatory and inhibitory activation received in parallel from various sociodemographic and driving-specific factors, through their collective influence on their psychosocial variables." This is consistent with the Older Driver Decision Components Framework in the current research wherein some variables play a supportive role in driving (*motivators*) while others play an inhibitory role (*constraints*), and still others have a variable impact (*constraint/motivators*). Wong also acknowledges that "information is not necessarily put into the network in a sequential manner" although the MOTRS model falls short in outlining how this actually occurs. The Decision Components Framework addresses this weakness in illustrating how individuals integrate information within a sphere of cognitive activity, with individual variables being considered, combined, discarded and recombined a number of times until the final solution is chosen.

Another common aspect of the current work and that of Wong concerns initiation of behaviour change. Wong and colleagues describe how, consistent with connectionist frameworks (Smith, 1996), a change in a variable (e.g., relocation to an urban area) can generate excitatory or inhibitory activation of factors. This concept appears similar to the notion, incorporated in the current work, of decision frame triggers that stimulate movement from habitual to conscious decision-making (Hollmann et al., 2015). But whereas the MOTRS model suggests sociodemographic and driving-specific factors always influence self-regulation, the current work does not support this assumption. Rather, the current work suggests driving, even self-regulated driving, follows a habitual pattern not consciously affected by factors such as health, society attitudes, driving experience or road conditions, until a novel event triggers the need to consider such items.

The models produced in the current research add substantial value to the existing models for several reasons. First, the models adopt a broad view, without assumption that the driving behaviour exhibited by the individual represents self-regulation in response to declining resources. By addressing questions from the perspective of the driver, and documenting the driver's decisions and decision processes, the work represents an

inductive approach to understanding self-regulated as well as unregulated driving. Second, the Decision Components Framework was developed through an extensive review of all types of literature on older drivers, including qualitative studies with elders' statements about driving decisions. This resulted in a far more comprehensive set of variables considered during the study, and ultimately included in the framework. Third, this research used an interdisciplinary approach to studying older drivers by considering established theories of aging, travel demand, risk, driving, and decision-making, resulting in more complete models. Figure 2, for example, integrates P-E fit, decision theory, and models about habit to better understand the context of driving decisions. Finally, the models produced in this research are probably the first to attempt to explain how information is selected and combined to arrive at everyday travel choices without external judgement of safety resulting from those choices. In this regard, the models presented here may be more representative than others, and could add clarity to existing models.

8.1.2. Evaluating Environmental Fit

Person-Environment Fit may be applied to driving by describing positive and negative outcomes as a consequence of a (mis)match between the personal resources of the individual and the driving environment. As age-related changes increase, individuals are challenged to make decisions on whether they still have sufficient resources to manage the demands of driving. This information, it is believed, is incorporated into decisions about whether or not to drive. The literature contains information about how elders appraise their health declines, but much less is known about how they interpret their driving environment. This research set out to explore the latter.

The published literature on older drivers approaches the question of how elders assess their personal fit within the driving environment mainly through examination of its outcomes (i.e., quantifying self-regulation practices), and the personal factors that contribute to those outcomes. Recently, Molnar, Eby, Zhang et al (2015) compiled a review of the literature on self-regulation. They found that the research has examined driver-related factors including: demographics; health and functioning; awareness of and insight into functional declines; family and social support; confidence and comfort with driving; and more general perceptions about one's capacities. Recommendations for

further research included, *"Research on self-regulation needs to move beyond simply asking older drivers about avoidance behaviors…Multiple levels of driver performance and decision-making should be used as a framework for thinking about the decisions that older adults make with regard to self-regulation".* The current research addresses these concerns.

In this study, a phenomenological approach was used to encourage deep thought about particular driving experiences. To this end, a photo sorting task was used to uncover tacit knowledge. Using the photo sorting task and statistical techniques, this research found three separate underlying constructs of how elders think about and evaluate their driving environment. Of particular note is that the methods revealed that older drivers do not evaluate driving as a whole, but as a combination of three distinct aspects, each of which is measured separately. It is possible that in making decisions, that individuals do not include all three of the constructs in their decisions, or that some are given more consideration than others. This has important implications for improving older driver program development through addressing each of these components separately. Policy development might also benefit from examining older driver decisions, separately, within these three dimensions. This study found that one of the constructs, labelled *Driving Environment* is defined in terms of items such as roadways, weather and traffic. A second construct, labelled *People Who Drive*, includes concepts related to other road users. A third construct, *Crashes*, contains the causes and results of vehicle impacts.

The identification of three distinct constructs that individuals evaluate in their driving environment contributes an important new perspective in understanding P-E fit for driving and the individual's evaluation of their own resource-environment balance. P-E fit models do not specify various aspects of the environment, which could indicate a weakness in the model. For example, in applying P-E fit to driving, the 'driving environment' may be interpreted as a single entity and the resources of the individual measured against this lone construct. The current research indicates at least three separate constructs make up the 'driving environment', and that the resources of the individual should be measured in relation to each of these, separately, to determine if a balance exists for each. Although not specifically addressed in this research, the resources of the individual, likewise, may be made up of a number of distinct facets (e.g.,

cognitive resources, physical resources, emotional resources), each of which would need to be evaluated in relation to the distinct environmental facets. Such complexity is not addressed in classic P-E fit models. Further research is needed to explore questions such as, “What personal resources does the individual consider when evaluating their fit with the *People Who Drive* component of the driving environment, and how does this differ from the *Crashes* environment?”

In addition to revealing three distinct components of the driving environment, statistical modelling revealed that the participants in the study evaluate each of the three major constructs along three dimensions: 1) driving difficulty, 2) sense of control, and 3) amount of attention or vigilance needed, although interpretation of the third dimension was more difficult. For example, within the *Driving Environment* construct, driving difficulty is measured along a continuum, with a progression from uncluttered and simple to complex and congested, representing low to high driving difficulty, high to low sense of control, and low to high need for vigilance. Drivers who have difficulty concentrating, for example, may avoid situations requiring high need for vigilance (cluttered signs in heavy traffic) but still feel they are capable of adequate vehicle control (e.g., bad weather on a quiet country road). This finding supports the assumption, stated above, that individuals consider different aspects of their personal resources in evaluating their ability to cope with driving.

Qualitative interviews with participants in this study support the above quantitative analysis and provide a richer understanding of the driving experience. For example, the women in this study were more conscious of the busyness of city driving environments and spoke openly about avoiding these situations. This suggests they experience driving in terms of level of stimulation. The men also identified challenging situations but were more likely to say they would *not* avoid them – they seemed to be expressing that they experience driving as an activity associated with control.

Findings such as these concur with other studies. The published literature on older drivers also supports that women are more likely than men to use avoidance in their driving decisions (Molnar, 2008). Studies have found that men see driving as a static skill within a changing environment whereas women see driving as an intrinsic skill that changes due to aging and declining ability (Donforino et al., 2008). Such differences between how men

and women interpret their driving experiences (externally generated stimulation versus internally generated control) suggest there are differences between genders in how they understand and value their experience and process similar information. This may have important implications in how they make driving decisions. For example, whereas women appear to interpret their own distractions as the major cause of crashes, men appear to believe crashes are caused mainly by the generally poor driving skills of others. Consequently, women may avoid roadways with cluttered signage or complex pavement markings, whereas men may not use avoidance, but instead compensate for the bad driving of others by focusing on their own abilities to maneuver their vehicle. These differences could result in contrasts between genders, for example, of decisions about when and where to drive. Again, programs to support aging drivers could be improved by acknowledging these differences and addressing the weaknesses of each.

D'Ambrosio and colleagues (2012) support these findings. In their focus group study of older drivers, these authors also concluded that women make different driving decisions than men based on their different interpretations of context. For example, women were generally united in their efforts to eliminate distractions within the vehicle, when they were driving, to improve their performance. Several of them discussed how they no longer listened to the radio or any music, avoided eating or drinking while driving, and did not allow others to talk or carry on conversations in the car. All of these were considered distractions that detracted from the ability to drive safely. Their behaviours suggest they evaluate the environment as highly demanding and they attempt to increase their sense of control. Men on the other hand felt that their driving might improve only with increased practice and time driving, and they did not talk about strategies in response to information about age-related declines. Consequently, men may use less information in their driving decisions, or place lower values on their measurement of driving difficulty or need for vigilance.

The clinical implications of these findings are that older drivers may evaluate three different components of their driving environment separately, using different measurement criteria for each. It follows, then, that an individual may be more or less accurate in their evaluations of the different components, which may in turn affect their driving decisions and therefore their driving risk. For example, an individual may adequately evaluate their

ability to cope with other drivers on the road, but not with the need for constant vigilance. Further work is needed to identify areas of weakness in older drivers' evaluations, and to design strategies and programs to mitigate these weaknesses.

8.1.3. Driving Decision-Making

Behavioural Decision Theory describes decision-making as making trade-offs between various gains and losses in relation to the status quo to arrive at a sufficiently good solution. Results of this study lend general support for this theory. First, in making their decisions, the participants frequently referred to the status quo with statements such as, "I always walk to my doctor's" or "I always drive to the store". Second, the participant's next step was to acknowledge information about conditions that might threaten the suitability of the status quo, such as heavy rain that would make walking difficult. Finally, it was noted that not all information offered to the participants was used, even if the information appeared to be relevant to the decision. Instead, participants typically chose one or two key items in making a decision, an approach termed 'satisficing' or 'good enough' in Decision Theory.

Driving decisions for older adults typically involve at least some amount of self-regulation that includes trade-offs, for example, delaying a trip to avoid rush hour or driving further to avoid a busy intersection. Understanding how such trade-offs occur was addressed in this phase of the research. Hassan, King and Watt (2015) used focus groups to explore a 7-step process of self-regulation, from unawareness to maintenance. Although they explored the meaning of driving and self-evaluation of driving abilities, their study did not provide information about how elders integrate their views of self with their understanding of the driving environment.

Recent findings are that self-regulation is not the exclusive domain of elders; younger drivers also engage in avoidance behavior. In a study of 48 drivers age 18-75 years, Gwyther and Holland (2012) identified anxious driving style and negative affective attitudes, as independent predictors of self-regulation. After controlling for driving experience they found that self-regulation increased with age, and there was a strong association between feelings of vulnerability/low confidence and driving behavior. These

results suggest there are age-related changes that undermine the confidence of elders to manage the driving environment. Within this study, the confidence level of participants are somewhat lower than found in other research studies. Recent studies by Riendeau, Maxwell, Patterson and colleagues (2016) confirmed findings of others that individuals tend to over-rate their driving abilities. In their study of Canadian drivers (mean age 75 years), none of the drivers rated themselves as more likely than others to be involved in a crash despite the fact that half of the 74 participants failed the on-road driving evaluation. Additionally, 92% of those who passed the on-road test either agreed or strongly agreed that they had the skills to get out of a dangerous driving situation, but of those who failed, 92% held the same belief. Furthermore, the overall daytime and nighttime driving comfort levels for those who passed was 65.5%; almost equal scores (65.6%) were observed for those who failed, although scores for driving comfort varied considerably between individuals.

One of the most consistent findings in the literature has been that perceptions of confidence or comfort in specific driving situations are closely related to self-regulation (e.g., Baldock et al., 2006; Blanchard & Myers, 2010). It is believed that this concept of comfort reflects the individual's appraisal of their P-E fit within the driving environment. However, it remains unclear how these factors are used by the individual in their decisions to self-regulate. The current research sought to explore how these aspects are integrated into driving decisions.

The published literature on older drivers has included numerous studies on factors that seem to affect driving self-regulation. For instance, the role of declining vision (e.g., Ball et al., 1998; Charlton et al., 2006; Stalvey & Owsley, 2000), cognitive changes (e.g., Adler, 2010; Festa, Ott, Manning, Davis, and Heindel, 2013), and physical function (e.g., Molnar et al., 2014; Tuokko, Rhodes & Dean, 2007) have been studied extensively. Myers, Trang and Crizzle (2011) demonstrated that elders may modify their driving patterns in response to bad weather, including trip postponement and cancellation, however other factors such as not feeling well, scheduling conflicts, emergencies, and car problems were also cited as reasons. The relative contribution of each of these factors was not determined.

In the current research, the use of information in decision-making was explored using decision scenarios and an item-selection task. The **Older Driver Decision Components Framework** was used to guide construction of these tasks.

Participants in this study identified 22 items of information they typically use in making their decisions about whether to drive. Transportation goals, intrapersonal items such as habit and emotions, self-efficacy for driving, and physical aspects of cars constituted 25% of items used in driving decisions. This group of items, used mainly to support a decision to drive, represent *Motivators* described in the (revised) **Older Driver Decision Components Framework**. The majority of items used in decisions (73%) were associated with elements of the driving environment, health, and alternatives to driving. These items were recognized as barriers to driving in some instances, but alternately as supporting information in other instances. Accordingly, they were identified as *Constraints/Motivators* in the revised Framework. The third group of *Context* items, included interpersonal, societal, and legal issues as well as living arrangements, but these were rarely (2%) cited for inclusion in decisions. Differences were found across habit strength and gender with regards to the types and amounts of information used.

Other studies have shown similar results in terms of the categories of information that may be used in driving decisions, however they have not attempted to quantify the amount of information or items used. In a study of self-regulation among drivers over age 50, Donforino et al. (2009) reported descriptions of self-regulation could be categorized into four dimensions: a) driving skills and abilities; b) life and society; c) automobile; and d) self-worth. Further, each of these dimensions contained a single important theme, respectively: a) declining confidence; b) increased dependence; c) importance of independence; and d) lack of public transportation. Two dimensions (self-worth; vehicle) correspond to *Motivators* in the current study while the remaining two (life and society; driving skills and abilities) correspond more closely to *Context information*. Additionally, ‘confidence’ and ‘independence’ cited by Donforino and colleagues are conceptualized in this study as *Constraints* and *Motivators*, respectively; lack of public transportation is also included in the current study as a *Motivator*. Differences between this study and that of Donforino and colleagues exist primarily in identifying *Constraints* in the current research, which includes health, driving environment, and legal aspects of driving

The current research revealed differences in how individuals use specific items of information, i.e., the decision processes they use. Differences across individuals were found for the number and types of information used. Further, it was found that the same information items may be used in a different way by different individuals, and also that the same individual may use a single item of information differently under different circumstances. Therefore, this research supported the notions of others (Bettman, Luce & Payne, 1998) that individuals invoke different decision processes or strategies as contexts change.

The data was further analyzed using statistical techniques (cluster analysis). Three distinct clusters of individuals were revealed, based on the decision patterns of the participants. Differences were found across age, habit strength and gender. One cluster, labelled **Relationships Rule** was characterized as using primarily *Motivator* types of information in their decisions to drive, especially intrapersonal and goal motivators. This group tends to be female, median age, and have the highest driving habit scores and social motivation to drive. A second cluster, named **I'll Drive If I Have To**, use mainly *Constraints/Motivators* types of information in their driving decisions, especially environmental information such as weather, traffic, and distance. Members of this cluster tend to be younger females with medium habit for driving, and rely somewhat on other types of transportation such as transit or rides from others. The third cluster, labelled **How Do I Feel Today?**, tended to use a higher number of information items in their decisions, and to include all types of information. Members of this cluster tended to be older males with low habit strength for driving. They have poorer health, drive less, and appear to have decreased skills as evidenced by their higher number of minor collisions. A survey of the literature did not reveal other studies describing different groups of older driver decision-makers.

These results suggest an expanded direction for research could encompass a broader examination of factors that influence older adults' decisions on driving and self-regulation. In this research, identification of the amount, types and combinations of information used in decisions highlights that single factors such as declining vision may play an important role, but its use in decision-making is variable. Further research could clarify the relationships between information items and their use in decisions, and

especially how this is affected by changes in context including psychosocial characteristics of the individual. The results also suggest further examination into possible categories of decision-makers, including a clarification and/or expansion of categories, and determination of whether they represent stable characteristics or a progression towards eventual driving cessation.

The clinical implications of these findings are such that programs to support safe driving could be better tailored to different types of decision-makers. Physicians, other health care professionals, and road safety experts often deliver general education about aging and driving, with mixed results (Rosenbloom, 2009; Sargent-Cox et al., 2011). Improved understanding of the characteristics, priorities, and needs of older adult groups could improve safety outcomes.

8.1.4. Influence of Others' Comments

The context within which older drivers make decisions includes interpersonal items such as the opinions of family and friends, social capital, and expectations of others. In the **Older Driver Decision Components Framework**, these items are considered *Context* factors. Published research on older drivers concludes that they acknowledge the role of family and friends in influencing driving decisions (Connell, Harmon, Janevic & Kostyniuk, 2012; Coughlin, Mohyde, D'Ambrosio & Gilbert, 2004). The results of the current research also agree with other findings that elders are more likely to listen to feedback about their driving from someone they trust and respect, and that provide evidence of the criticisms (Hassan, King & Watt, 2015), although with regards to the latter, the findings of the current research were variable. Little work by others has been directed towards identifying and quantifying the types of feedback most likely to have impacts on older drivers. One exception would be the work of Tuokko, McGee and Rhodes (2006) who found that older drivers who reported that their driving positively influenced others were less likely to make decisions about restricting their driving.

In the current sample of older drivers, two categories of statements exerted the most influence: 1) those supporting them to continue driving, and 2) those aimed at

encouraging them to limit their driving. Statements that they should stop driving, and especially statements of how to change their driving habits, had less impact.

Some participants demonstrated strongly polarized views about whether or not they would be influenced by others' comments, or, alternately, ignore them. This polarized effect varied by type of statement, but women were much more likely to demonstrate this behaviour. Two categories were created reflecting this polarization: *'You have to listen to your family'*, and '*I don't care about others' opinions'*. When examined across decision-making clusters, differences were found. For example, consistent with their social goal-oriented decisions, members of the **Relationships Rule** cluster were most likely to demonstrate a *You have to listen to your family* attitude. In contrast, the **I'll Drive If I Have To** cluster, with lower habit drivers, were equally divided between listening to other's comments or completely ignoring them.

These results provide important information for family members, as well as older driver program designers, by highlighting some types of comments more likely to have the desired influence on older driver decisions. Further research may add to this knowledge by exploring the effects of context on the likelihood of influence of different types of statements. Context may include elements such as the nature of relationships, urban versus rural residence, or cognitive status, in addition to elements that differentiated the decision-making clusters in this study. Recognition that the older population of drivers consists of distinct groups of decision-makers who react differently to comments about their driving may inform a new direction for research.

8.2. Limitations

The exploratory nature of this research and the small, convenience sample used, present significant limitations to the reproducibility and generalizability of the findings. Although the sample included a wide range of ages and income levels as well as both genders, all participants were Caucasian, had high levels of education, and normal cognitive function as measured by a standard cognitive screening tool. Most of the participants were very physically active and functionally healthy; the sample included only one participant with Parkinson's disease. However, several participants scored above the

norm on the Timed Up and Go test, indicating possible mobility challenges. All lived in a large urban area where transportation options (public transit, taxis, walking/cycling paths) were available. The literature on older drivers cites the influences of culture and ethnicity on driving habits, not represented in this research. For example, in a study of eight countries in Europe, Asia and Africa, (Nordfjaern, Simsekoglu & Rundmo, 2014) cultural factors were stronger predictors of driver behaviour than risk perception, and attitudes solely explained the variance in driver behaviour in three countries. For older adults, location of residence (urban versus rural) also contributes significantly to driving mobility in terms of fears for personal safety, perceived risk of crash, and access to alternative transportation (Marin-Lamellet & Haustein, 2015); the current research did not include rural or small urban centers. Haustein (2012) described four types of older drivers based on their health limitations and area of residence: *Captive Car Users* (restricted mobility), *Affluent Mobiles* (car-oriented), Self-*Determined Mobiles* (flexible transport modes), and *Captive Public Transport Users* (dependent on public transit). In the current study, only two of these four types were represented in the sample; individuals with restricted mobility or ability to access a vehicle were not included.

Data for this research was collected at a single point in time for each participant, so it is not possible to determine the stability of their decisions. Repeated sampling over time could help clarify whether individuals demonstrate the same patterns of decision-making on different days. This is especially relevant for defining groups of decision-makers as carried out in this research using cluster analysis. Since only one episode of scenario choices was undertaken, it was not possible to determine whether a single participant would be characterized in, say, Cluster 1 at one time and Cluster 3 at another time. Furthermore, it was not possible to explore circumstances, or individual characteristics, that might contribute to such a change. Of particular note is that this research did not address the influence of stable traits such as personality that are known to influence decisions (Erjavec, Khan & Trkman, 2016; Juanchich, Dewberry, Sirota & Narendran, 2015). Other studies support that the mobility of older adults changes over time, even short-term, and that these changes vary among individuals as short- and long-term physical changes alter mobility lifespace (Baker, Bodner & Allman, 2003; O'Connor, 2010). The cross-sectional nature of the current research represents significant limitations in understanding temporal effects related to decision-making.

A major limitation of this research could be the use of hypothetical decision scenarios, although the use of scenarios in decision research has been well established. Hypothetical scenarios require the participant to read, understand, and remember, which may place an unmanageable cognitive load on some older participants. Although all of the subjects in this study scored within the normal range on the MMSE, the cognitive demands of the scenarios were not measured. Some people are more adept at imagining a scenario than others, at placing themselves in the scenario, and at predicting a response, which may lead to variations in the quality of outcomes. In this study the scenarios were designed with different motivations for travel and different levels of intensity of items, and some were not relevant to all of the participants, threatening the validity of their responses. One example was that some participants said they were never sad or depressed as described in one of the items. However, in a study of gambling using young subjects, Kuhberger, Schulte-Mecklenbeck & Perner (2002) concluded, "the results show that people who imagine a hypothetical risky choice situation make the same choice as they make when dealing with a real decision." Whether these conclusions are applicable to older adults has yet to be determined.

Since this research was exploratory, the intent was to reveal the existence of some underlying constructs rather than to accurately quantify them. The card sorting task used to explore the meaning of driving was performed only once, using photos of items taken from the literature, to reveal some main underlying constructs. Other card sort research designs may provide a more thorough exploration. For example, ideas may first be generated by the participants themselves to reduce bias from the investigator. The *a priori* selection of items to sort may represent a limitation to identifying all relevant aspects of driving, even though a wide range of studies was reviewed in identifying items. Furthermore, photos selected for inclusion in the study were pre-screened for interpretation by only three test subjects; a larger test panel could improve the quality of the photos included. The sorting task could also be repeated numerous times by each participant until no new classifications are advanced (Rugg & McGeorte, 1997). This may improve the accuracy of the outcome.

Many of the measures used in this research were self-reports by the participants. It has been demonstrated that self-reports of driving behaviours (Blanchard, Myers &

Porter, 2010) and driving distance may not be accurate. Using a subsample from the Canadian Candrive II Study, Porter, Smith, Cull et al (2015) found only moderate agreement between self-reported distance travelled and actual distance measured by in-vehicle technology. Further, low exposure drivers tended to underestimate and high exposure drivers tended to overestimate their travel. These inconsistencies could impact the interpretation of the clusters defined in the current study in regards to their travel patterns. Nonetheless, about half of the subjects in the Candrive II study accurately estimated their travel distances.

Self-reports of health have also been demonstrated as unreliable (Willihan, Stump & Callahan, 1999). The objective measures of health used in this research (MMSE, TUG) are well established and validated but are essentially screening tools and provide only suggestive evidence of general cognitive and physical health. Further, the two measurement scales used in this research (Self-Reported Habit Index; Modified Interpersonal Relationship Scale) proved to be challenging for the participants, especially for items where negative wording occurred. Additionally, only a subset of questions from the MIRS was used and validity of the abridged version was not verified. Published scales that are easier for elders to use may improve this research. Alternately, new scales could be developed and validated for use in similar research.

Behavioral Decision Theory describes how individuals make trade-offs between various gains and losses compared to the status quo to arrive at a decision. The current research provided evidence of the types of gains and losses identified, but fell short in determining how they were evaluated and precisely how the trade-offs were made. For example, this study demonstrated that driving in traffic might represent a gain in convenience, but a loss in enjoyment. How the individual makes a trade-off between the possible gain versus the possible loss was not analyzed from the data.

8.3. Directions for Future Research

Road safety experts are on the cusp of a major shift in the demographics of the driving population, as the Baby Boom generation ages, from the current comparatively lower-risk, middle-aged cohort of drivers to a higher-risk cohort of elderly drivers. New

vehicle technologies, driver education programs, and new roadway designs are promising to mitigate some of the risk, but their benefits will be realized only if the aging population chooses to use them appropriately. It is therefore critical to understand how older drivers make decisions about their driving, especially what factors they consider important in their decisions, in order to design and promote future safety measures. Research design methods must be refined, and projects must be carried out that delve deeper into the processes behind driver decisions. As the population ages and new safety features are proposed, we must have the skills and knowledge needed to understand what strategies have the highest likelihood of success in protecting the safe mobility of all Canadians.

This research represents early efforts into exploring how older adults go about making day-to-day decisions about their driving. It represents a new direction in examining older driver decisions and the role of family and friends in those decisions, especially decisions leading to reduction and self-regulation of driving. The literature on older drivers is already rich in the taxonomy of self-regulatory behaviours; it is hoped that the research presented here will stimulate further work in a new direction of understanding *how* these behaviours are triggered. To this end, this dissertation presents some preliminary models of how elders evaluate and integrate different items of information, associated with their personal resources and the driving environment, to make active versus passive (habitual) driving decisions. These models were developed conceptually, and are therefore offered as 'straw dogs' to challenge other researchers to test, and refine or rebuild.

The current research could be improved through a refinement of methods. For example, future research should seek to confirm the results of this research using a large, random sample of older drivers of different cultural and socioeconomic circumstances. In particular, the research should include culturally diverse groups as well as rural residents in addition to large and small urban areas, since their transportation options and habits are known to differ (Edensor, 2004; Hanson & Hildebrand, 2011). Repeated measures and longitudinal studies should be used to test the stability of the findings, and to inform whether the male-female differences in self-restriction are cohort effects that may attenuate over time, especially as women who have been the primary family driver predominate. The decision scenario technique used in this research to define groups of decision-makers could also be conducted as a classical discrete choice experiment using

a large sample size that supports more rigorous statistical analyses (de Ryan, Gerard, & Amaya-Amaya, 2009). Observation studies of real decisions using instrumented vehicles, such as in the weather-induced self-restriction study by Smith, Porter, Cull et al., (2016), could be expanded to incorporate the driver's decision-making processes.

Finally, future studies should explore more complex causal relationships between the driving environment, changes in personal resources and driving decisions. For instance, although results of the current study suggest changes in health may trigger driving decisions, further work could determine whether the onset of arthritis results in avoidance of a particular driving behaviour or whether the behaviour arises from other influences such as changes in attitudes influenced by family.

8.3.1. Applications for this Work

The models presented in this thesis were developed to evolve a deeper understanding about how elders adapt, through their decisions and subsequent behavioral changes, to age-related declines that affect their driving. The preliminary models were formed by combining existing knowledge from the published literature on older drivers with theories of aging and decision-making. These early models were very important in helping to gain a deeper understanding of gaps in the existing research, and to formulate questions for the study. The models helped guide a better understanding of the relationship between declining personal resources and how this affects decision making. They also helped to organize our knowledge about aging and driving, and to guide a systematic approach to the study. It is hoped that the models presented here will be helpful for other researchers in stimulating further thought about adaptation to aging, not only within the context of driving but within other contexts. For example, the integration of P-E fit with behaviour decision theory could offer a worthwhile approach to studies of leisure activity, and a decision framework similar to the one presented here could be developed to improve knowledge of how elders make decisions about adapting their leisure activities to accommodate the aging process.

This research also contributes to our understanding of research methods that can be used effectively to study older adults. Research with older adults carries

methodological challenges tied to distinct aspects of the older adult population, such as age-related physical and cognitive changes, generational influences, and social attitudes (Chase, 2014). During research studies, older adults may experience memory deficits and difficulty with recall, diminished vision and hearing, increased time to react, and fatigue (Charness, 2008). Frequent prompting may be needed during the study, and written materials must be prepared to aid vision, meet various levels of education, and enhance interpretation. Furthermore, “one size fits all” study designs such as surveys are often not appropriate for older adults (Lindquist, Covinsky, Langa et al., 2014) who may also have strong prejudices or biases and social traditions that must be considered during communication. The current study used a mixed methods approach employing different tasks designed specifically to accommodate age-related challenges, especially fatigue and boredom. Rather than requiring participants to conform to a structured questionnaire or interview, the older adults in the study were allowed to work in their own way and at their own pace to produce the data. Changing tasks, alternating talk-aloud time with quiet reflection time, and interjecting physical movement into the study were used to enhance engagement. This approach worked very well as evidenced by the high completion rate and the considerable amount of time participants were willing to be engaged in the research. In particular, many of the participants in the study found the card-sorting tasks to be a type of play that appealed to their visual, kinesthetic, and cognitive senses. Furthermore, the use of these methods allowed data to be collected both visually and verbally according to the abilities and preferences of the participants. This enabled more complete data collection that increased the richness of the results. This approach, and the methods used in this study, may prove valuable to research in other areas involving older adults.

8.4. Concluding Remarks

This research presents an important change in direction in the study of older drivers, by exploring the processes involved in driving decisions rather than focusing on identifying the outcomes of these decisions (i.e., self-regulation behaviours and cessation of driving). Understanding how people make decisions about their driving is seen as a

critical component in developing successful safety policies, products, and programs that will be used effectively by the individuals they are targeting.

The primary impact of the current research, for the applied goal of enhancing traffic safety, is that decisions about driving made by older adults is dependent upon at least three main features: 1) how older adults interpret their driving environment; 2) the types of information they use and the decision processes they invoke; and 3) the types and amount of influence others have in changing their perspectives about their driving decisions. Programs may be developed to address each of these successfully, but only if a good understanding of each is attained. The current research contributes preliminary knowledge; further work is needed to expand and refine that knowledge.

Overall, this work shows that groups of older adults exhibit distinct decision styles, and that demographic, health, and habitual driving behaviour factors are related to these patterns. Although these results represent exploratory research outcomes, they suggest interventions may be improved through refined targeting of sub-populations of elders. However, successful accomplishment of this task is dependent upon adopting new directions of investigation suggested by this research.

It is hoped that this research will contribute to a stronger understanding of older driver behaviour, and encourage further dialog and investigation into areas related to safe mobility. Mobility is a critical consideration for an aging population since the attainment of instrumental and social goals is often highly dependent on travel. The issue of safe mobility for older adults will therefore become increasingly salient over the next few decades as population aging continues. Given that safe transportation is a major contributor to psychological, social and physical wellbeing, it could be considered a basic human need alongside shelter, health, education, family planning, nutrition, and water (CIDA, 1997).

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Appendix A.

Demographics Questionnaire

SFU SIMON FRASER UNIVERSITY Driving Decisions of Older Adults ID # _____

Demographics Questionnaire

1. What is your age? __ __ __

2. What is your gender?
   ☐ Male ☐ Female ☐ Other

3. Are you currently…
   ☐ Living with a partner or spouse
   ☐ Living alone
   ☐ Living with another relative
   ☐ Living in part of the same dwelling as a relative
   ☐ Sharing accommodation with someone not related
   ☐ Other (describe) _____

4. What type of dwelling do you live in?
   ☐ A detached house
   ☐ An apartment or condominium
   ☐ A Senior's or Retirement facility that provides transportation
   ☐ A senior's or retirement facility that does NOT provide transportation
   ☐ Other (describe)_____

5. How long have you lived at your current location?
   ☐ Less than a year
   ☐ One to 5 years
   ☐ More than 5 years

6. How many people INCLUDING YOURSELF live in your household? _____

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7. Do you have access to a car to drive? ☐ Yes ☐ No

8. Do you have public transit within 2 blocks of your residence?

   ☐ Yes ☐ No

9. How often do you use public transit?
   - ☐ Never
   - ☐ Rarely
   - ☐ About half of the trips I make
   - ☐ Most of the time
   - ☐ Always

10. How often do you use specialized transport such as Handi Dart?
    - ☐ Never
    - ☐ Rarely
    - ☐ About half of the trips I make
    - ☐ Most of the time
    - ☐ Always

11. How often do you take a taxi?
    - ☐ Never
    - ☐ Rarely
    - ☐ About half of the trips I make
    - ☐ Most of the time
    - ☐ Always

12. Do you work outside the home for pay?

☐ Yes ☐ No

13. If you work outside the home for pay, how often do you go to work?

☐ Full-time
☐ Part-time
☐ Occasional

14. Which of the following income groups includes your TOTAL HOUSEHOLD INCOME last year, before taxes?

☐ Less than $20,000
☐ $20,000 to $49,999
☐ $50,000 to $79,999
☐ $80,000 to $99,999
☐ $100,000 or more

15. What is the highest grade or level of school you completed?

☐ Some high school or less
☐ High school degree or equivalent
☐ Some college or technical
☐ College degree
☐ Some graduate education
☐ Graduate degree or higher

Appendix B

Health Questionnaire

SFU SIMON FRASER UNIVERSITY

Driving Decisions of Older Adults

ID # _____

Health Questionnaire

I would like to ask you some questions about your health.
If there are questions that you do not want to answer, you may leave them blank.

Place an X in the box to mark your choice, e.g. ☐ Good

1. In general, would you say your health is…	Excellent	Very Good	Good	Fair	Poor
2. Compared to 1 year ago, how would you rate your health in general now?	Much Better	A bit better	About the same	A bit worse	Much worse
3. Compared to others your age, would you say you are…	Much healthier	A bit healthier	About the same	A bit less healthy	Much less healthy
4. How much pain have you had during the past 4 weeks?	None	Very mild	Moderate	Severe	Very severe
5. In which area of your body do you have **the most** pain?	Head or neck	Shoulders, arms or hands	Legs or feet	Hips or lower abdomen	Back or chest
6. How many prescription medications do you take daily?	None	1	2	3 - 5	More than 5

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7. During the past month, how much of the time have you been feeling…

Full of pep and energy	Always	Occasionally	Sometimes	Rarely	Never
Downhearted or blue	Always	Occasionally	Sometimes	Rarely	Never
Tired or worn out	Always	Occasionally	Sometimes	Rarely	Never
Happy or optimistic	Always	Occasionally	Sometimes	Rarely	Never

8. Over the next 6 months do you expect your health to…	Improve a lot	Improve somewhat	Stay about the same	Decline somewhat	Decline a lot

9. Do you feel your health limits you in these activities:

Lifting or carrying groceries	I cannot do this	Limited a lot	Limited a little	Not limited at all
Walking one block	I cannot do this	Limited a lot	Limited a little	Not limited at all
Climbing 3 or more flights of stairs	I cannot do this	Limited a lot	Limited a little	Not limited at all
Bending to pick something up off the floor	I cannot do this	Limited a lot	Limited a little	Not limited at all
Opening a jar of pickles	I cannot do this	Limited a lot	Limited a little	Not limited at all
Balancing on one foot for 15 seconds	I cannot do this	Limited a lot	Limited a little	Not limited at all
Driving a car	I cannot do this	Limited a lot	Limited a little	Not limited at all

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10. Have you ever been told by a doctor or health professional that you have the following…

	Yes	No	Maybe
High blood pressure	☐	☐	☐
Heart attack or heart problems	☐	☐	☐
Stroke	☐	☐	☐
Migraine or Seizures	☐	☐	☐
Parkinson's	☐	☐	☐
Arthritis or joint swelling	☐	☐	☐
Glaucoma or Macular Degeneration	☐	☐	☐
Diabetes	☐	☐	☐
Alzheimer's or Dementia	☐	☐	☐
Neuropathy or nerve damage	☐	☐	☐
Sleep Apnea or sleep disorders	☐	☐	☐
Depression, Anxiety or other mood disorder	☐	☐	☐
Pulmonary disease (e.g. COPD)	☐	☐	☐
Other major illness	☐	☐	☐

Appendix C

Driving Habits Questionnaire

SFU
SIMON FRASER UNIVERSITY

Driving Decisions of Older Adults ID # _____

Driving Questionnaire

1. How old were you when you first got your driver's license? AGE: _____ years
2. How many years have you been driving? _____ years
3. About how many days per week do you usually drive? _____ days
4. About how many hours per week do you usually drive? _____ hours

5. About how many of your trips do you drive alone?	0 – ¼	¼ to ½	½ to ¾	¾ to all

	YES	NO	DON'T KNOW
6. Do you own your own vehicle?	☐	☐	☐
7. Have you had any periods when you were not permitted to drive because of illness?	☐	☐	☐

8. Does your driver's license say you are restricted from driving...	YES	NO	DON'T KNOW
On a highway	☐	☐	☐
A limited distance from home	☐	☐	☐
During the dark or night time	☐	☐	☐
Other	☐	☐	☐

9. How fast do you usually drive compared to the general flow of traffic?

Much faster	A bit faster	The same speed	A bit slower	Much slower

10. How would you rate the quality of your driving?

Poor	Fair	Average	Good	Excellent

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11. How confident do you feel when you are driving?

Not at all confident	A little confident	Average	Quite confident	Very confident

12. How difficult is driving for you?

Very difficult	Quite difficult	Not difficult	Quite easy	Very easy

13. Do you ever ask a passenger to help when you are driving
e.g. reading signs or looking for hazards

Never	Rarely	Sometimes	Often	Always

14. What percent of your driving time do you try to AVOID...

	Never	**25%**	**50%**	**75%**	**Always**
Driving when it is dark					
Backing up					
Making a left turn					
Driving on highways					
Driving during rush hour					
Parallel parking					
Driving in bad weather					

15. In the past 6 months, how many times have you *lightly* bumped into something while driving? (with or without leaving a mark on the car)

Never	Once	Twice	Three or more times

16. In the past 3 years, how many crashes have you had where someone was injured?

None	One	Two	Three or more

17. In the past 1 year, how many traffic violation tickets or warnings have you had?

None	One	Two	Three or more

Appendix D

Mini Mental Status Examination

Mini-Mental State Examination (MMSE)

Patient's Name: _____ Date: _____

Instructions: Score one point for each correct response within each question or activity.

Maximum Score	Patient's Score	Questions
5		"What is the year? Season? Date? Day? Month?"
5		"Where are we now? State? County? Town/city? Hospital? Floor?"
3		The examiner names three unrelated objects clearly and slowly, then the instructor asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible.
5		"I would like you to count backward from 100 by sevens." (93, 86, 79, 72, 65, ...) Alternative: "Spell WORLD backwards." (D-L-R-O-W)
3		"Earlier I told you the names of three things. Can you tell me what those were?"
2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them.
1		"Repeat the phrase: 'No ifs, ands, or buts.'"
3		"Take the paper in your right hand, fold it in half, and put it on the floor." (The examiner gives the patient a piece of blank paper.)
1		"Please read this and do what it says." (Written instruction is "Close your eyes.")
1		"Make up and write a sentence about anything." (This sentence must contain a noun and a verb.)
1		"Please copy this picture." (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All 10 angles must be present and two must intersect.) 
30		TOTAL

Appendix E

Self-Reported Habit Index

SFU SIMON FRASER UNIVERSITY

Driving Decisions of Older Adults

ID # _____

Habit Strength for Driving Questionnaire

	Strongly DISagree	Disagree	Neutral	Agree	Strongly Agree
When I have somewhere to go, I often drive myself.	☐	☐	☐	☐	☐
When I have somewhere to go, I just automatically get in my car and drive there.	☐	☐	☐	☐	☐
I need to consciously remember that I can drive to where I want to go.	☐	☐	☐	☐	☐
When I want to go somewhere, it feels weird if I don't drive myself.	☐	☐	☐	☐	☐
I usually drive myself without thinking about it.	☐	☐	☐	☐	☐
It would take effort for me NOT to drive myself.	☐	☐	☐	☐	☐
Driving is part of my regular routine.	☐	☐	☐	☐	☐
If I had to go somewhere, I would find it hard not to drive myself.	☐	☐	☐	☐	☐
I have no need to think about driving myself somewhere.	☐	☐	☐	☐	☐
Driving is typically "me".	☐	☐	☐	☐	☐
I have been driving myself for a long time.	☐	☐	☐	☐	☐

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Appendix F

Modified Interpersonal Relationship Scale, Abbreviated

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Relationship Questionnaire – Wife

ID # _____

	Strongly **DIS**agree				Strongly **Agree**
There are times when my wife cannot be trusted	1	2	3	4	5
My wife would tell a lie if she could gain by it	1	2	3	4	5
In our relationship, I have to be alert or my wife is likely to take advantage of me	1	2	3	4	5
I'm better off if I don't trust my wife too much	1	2	3	4	5
In our relationship, I am occasionally distrustful and expect to be exploited	1	2	3	4	5
My wife can be counted on to do what she says she will do	1	2	3	4	5
I do not believe my wife would cheat me even if she could get away with it	1	2	3	4	5
My wife can be relied on to keep her promises	1	2	3	4	5
The advice my wife gives cannot be regarded as being trustworthy	1	2	3	4	5
I feel comfortable expressing almost anything to my wife	1	2	3	4	5
In our relationship, I feel I am able to expose my weaknesses	1	2	3	4	5
I do not show deep emotions to my wife	1	2	3	4	5
I share and discuss my problems with my wife	1	2	3	4	5
I tell my wife some things of which I am very ashamed	1	2	3	4	5
It is hard for me to tell my wife about myself	1	2	3	4	5
My wife really cares what happens to me	1	2	3	4	5

.....Turn over for Page 2

	Strongly **DIS**agree				Strongly **Agree**
It is safe to believe that my wife is interested in my welfare	1	2	3	4	5
My wife is truly sincere in her promises	1	2	3	4	5
My wife is sincere and practices what she preaches	1	2	3	4	5
My way of doing things is apt to be misunderstood by my wife	1	2	3	4	5
I feel my wife misinterprets what I say	1	2	3	4	5
I sometimes stay away from my wife because I fear doing or saying something I might regret afterwards	1	2	3	4	5
My wife doesn't really understand me	1	2	3	4	5
I would like my wife to be with me when I receive bad news	1	2	3	4	5
I feel relaxed when we are together	1	2	3	4	5
I listen carefully to my wife and help solve her problems	1	2	3	4	5
I understand my wife and sympathize with her feelings	1	2	3	4	5

Appendix G

Timed Up And Go Test (TUG)

SFU SIMON FRASER UNIVERSITY

Driving Decisions of Older Adults

ID _____

TIMED-UP-AND-GO (TUG) TEST

The Calgary Zone Fall Prevention Initiative recommends the Timed Up & Go (TUG) test as a screen to identify falls risk, and for identification of gait and balance abnormalities.

We recommend a cut-off score of ≥ 15 seconds as predictive of falls risk (referenced from the Canadian Fall Prevention Curriculum, 2007).

It is recommended that this score and/or any noted abnormalities in gait, balance or difficulty rising from the chair requires further assessment of falls risk factors, with appropriate facilitation of intervention(s) and referral(s).

Time to Complete:
- 1-2 minutes

Equipment Required:
- Armchair – approximate seat height = 43-46 cm and approximate arm height = 65 cm
- Measuring tape to measure 3 meter distance referred to below
- Line on the floor 3 meters away from chair
- Walking aid, if required
- Stopwatch

Client Start Position:
- Wears regular footwear
- Seated in arm chair
- Back against the chair, arms resting on chair arms
- Uses customary walking aid

Test:
- Client: From start position, client stands, walks a distance of 3 meters (there must not be any obstructions), turns, walks back to the chair, and sits down
- Assessor: Start timer on the word "go"; Stop timer when the client sits down i.e. client's buttocks contact the chair

Practice:
- One practice walk is allowed - Record test result on 2nd trial

Instructions:
- 'On the word "go", get up, walk at a comfortable, safe pace to the line on the floor, turn, return to the chair and sit down'

Record:
- Note difficulties in getting out of the chair, walking, turning and/or sitting down

* A score of ≥15 seconds indicates client has increased falls risk

Date	Time in Seconds to Complete (TUG) Test	Gait Aid Used	Difficulties Identified
		❒ Cane ❒ Two canes ❒ 4-Wheeled walker ❒ 2-Wheeled walker ❒ Solid walker ❒ No mobility aid	

Reference: J Am Geriatr Soc 1991, 39:142-48; Phys Ther 2000, 80:896-903

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Appendix H

Scenarios

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Driving Decisions of Older Adults

Scenario 1.1

A	B
You have a regular appointment to get your blood checked	You have completely run out your most important medication, and need to get a new prescription from the doctor
There is no bus or taxi available	The bus stop is just 2 doors down from your house and runs quite often
You are going only about a mile away, and you know the route well	You are going to a new place, and you are not sure where it is
You feel you have some limitations because of your age	You are totally capable
It is 8:30 am, Tuesday	It is 10:30 am, Tuesday
You consider yourself to be very healthy and feel much younger than your age	Your arthritis makes it hard to turn your head sideways
You rear-ended another car a few days ago	You have been driving for many years and never had a crash
You are just getting over having a cold	You feel healthy and full of energy today
It is a sunny day	It is cloudy with a bit of light rain at times

Scenario 1.2

A	B
If you miss this doctor's appointment to check about your knee pain, you will have to wait 2 weeks for another appointment	You have completely run out your most important medication, and need to get a new prescription from the doctor
It is cloudy with a bit of light rain at times	It is a sunny day.
You feel that you will enjoy the day, today	You are feeling quite sad and depressed
Your son once said he's not your taxi driver	Your daughter is always happy to drive you anywhere
You have a new vehicle that is great to drive	The shape of your car windows make it a bit hard to see when changing lanes
You feel very tired today, have a bad headache and ache all over	You are just getting over having a cold
You consider yourself as good a driver as others your age	You consider yourself an excellent driver
It is Sunday morning	It is 10:30 am, Tuesday
You are going only about a mile away, and you know the route well	You are going to a new place, and you are not sure where it is

Scenario 2.1

A	B
You would like a new pair of shoes and planned to go shopping today	You have just come home from vacation and have no food in the house
The bus stop is just 2 doors down from your house and runs quite often	There is no bus or taxi available
It is a sunny day.	It started to rain heavily about an hour ago
Your friend will give you a ride if you need it	Your son once said he's not your taxi driver
Your doctor has warned that you should consider giving up driving soon	Your doctor has never mentioned anything about driving
You rear-ended another car a few days ago	You have been driving for many years and never had a crash
You are often short of breath, even walking to the car	Your arthritis makes it hard to turn your head sideways
It is 8:30 am, Tuesday	It is Sunday morning
You have to travel across town, but you've been there lots of times before	You are going only about a mile away, and you know the route well

Scenario 2.2

A	B
You are almost out of vegetables and your favourite produce store is closed tomorrow.	You have just come home from vacation and have no food in the house
You have to travel across town, but you've been there lots of times before	You are going only about a mile away, and you know the route well
You have a new vehicle that is great to drive	The shape of your car windows make it a bit hard to see when changing lanes
Your family has criticized your driving lately	Your family has never said anything about your driving
It is 8:30 am, Tuesday	It is 10:30 am, Tuesday
You consider yourself an excellent driver	You consider yourself as good a driver as others your age
You are just getting over having a cold	You feel healthy and full of energy today
It is a sunny day	It started to rain heavily about an hour ago
Your son once said he's not your taxi driver	Your friend will give you a ride if you need it

Scenario 3.1

A	B
You meet some friends three times a week at a coffee shop and you'd like to go today	You have finally managed to schedule a visit to a friend that you have not seen for 6 months
Your daughter is always happy to drive you anywhere	Your son once said he's not your taxi driver
You have a new vehicle that is great to drive	Your car has been having battery problems and won't start every time
Your family has criticized your driving lately	Your family has never said anything about your driving
You almost hit a pedestrian last week	You have been driving for many years and never had a crash
Your arthritis makes it hard to turn your head sideways	You are very healthy and feel much younger than your age
It started to rain heavily about an hour ago	It is cloudy with a bit of light rain at times
It is 8:30 am, Tuesday	It is 10:30 am, Tuesday
You are going to a new place, and you are not sure where it is	You have to travel across town, but you've been there lots of times before

Scenario 3.2

A	B
There is a festival in the park, and lots of people you know will be there	You have finally managed to schedule a visit to a friend that you have not seen for 6 months
You have to travel across town, but you've been there lots of times before	You are going to a new place, and you are not sure where it is
You have a coupon for a free bus/taxi anywhere in the city	The bus stop is just 2 doors down from your house and runs quite often
It is a sunny day	It is cloudy with a bit of light rain at times
Your doctor asked about your driving, but does not seem concerned	Your doctor has warned that you should consider giving up driving soon
You consider yourself an excellent driver	You consider yourself as good a driver as others your age
You are feeling quite sad and depressed	You have been worried about something this past week
You feel that your age has really caught up with you	You are totally capable
It is 10:30 am, Tuesday	It is Sunday morning

Appendix I

Family Statements