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Perception and Attitudes of Canadians living with Parkinson's disease towards using Advanced Driver Assistance Systems (ADAS)

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Abstract

Advanced driver assistance systems (ADAS) are becoming increasingly prevalent commercially and have potential to increase road safety for at risk populations, such as those with Parkinson's disease (PD). This thesis presents the results of a survey study (n= 153) exploring the perception and attitudes of Canadians living with PD towards using ADAS. Most participants had a favourable perception of perceived usefulness and perceived ease of use towards ADAS. Most participants found ADAS slightly, quite or extremely beneficial, good, rewarding and pleasant. Perceived ease of use and previous experience were determinants for intention to use ADAS in the next year. Perceived usefulness and perceived ease of were determinants for intention to purchase a vehicle with ADAS features in the future. These findings provide insight to optimize technology design and develop client-centered interventions to assist drivers with PD to incorporate these technologies into their driving.

Keywords

Parkinson's disease, Advanced Driver Assistance Systems, ADAS, perception, attitudes

Summary for Lay Audience

Parkinson’s disease (PD) is the second most common neurodegenerative disorder where approximately 100,000 Canadians are living with it. Persons living with PD commonly experience a decline in cognitive, motor, and visual functions as the condition progresses, which in turn can lead to various challenges in their everyday life including driving becoming increasingly challenging. As a result, individuals with PD are a higher risk population for impaired fitness to drive. Advanced driver assistance systems (ADAS) are a form of vehicle automation that assists drivers by automating certain aspects of the driving task such as speed control, collision avoidance, or lane changes. ADAS are becoming increasingly prevalent commercially and offers the potential to benefit drivers of all backgrounds, including at risk drivers who are learning to drive, older drivers or medically at-risk drivers. As such, ADAS constitute a potential intervention tool to increase road safety for at risk populations, such as those with PD. Drivers using ADAS would benefit by added driving confidence, increased number of years to drive across the lifespan, improved community mobility and increased quality of life if their concerns and perceptions around ADAS were adequately understood and addressed.

This thesis presents the results of a survey study (n= 153) exploring the perception and attitudes of Canadians living with PD towards using ADAS. Most participants had a favourable perception of perceived usefulness and perceived ease of use towards ADAS. Most participants found ADAS slightly, quite or extremely beneficial, good, rewarding and pleasant. Perceived ease of use and previous experience were determinants for intention to use ADAS in the next year. Perceived usefulness and perceived ease of were determinants for intention to purchase a vehicle with ADAS features in the future, though these results are to be interpreted with caution due to the reasoning that vehicle purchase decisions take numerous factors into account. These findings provide insight to optimize technology design and develop client-centered interventions to assist drivers with PD to incorporate these technologies into their driving.

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Chapter 1

1 Introduction

People are currently living longer than they ever have before. A large proportion of the population, especially in high and middle income countries, is expected to live beyond the age of 60 (World Health Organization [WHO], 2018). In fact, in 2015 the WHO estimated that there were 900 million people above the age of 60 (WHO, 2018). This number is expected to increase sharply to 1.4 billion by 2030 and 2.1 billion people by 2050 (WHO, 2018). In Canada alone, 7 million people among a population of almost 39 million are aged 65 and older (Statistic Canada, 2018; Statistics Canada, 2022). The increase in life expectancy affords us the opportunity to have more years to spend with loved ones or pursue new activities compared to past societies. However, a major age-related concern is the concurrent health decline of older adults (WHO, 2018).

While many people can live additional years in good health, age-related biological changes or conditions can also impact participation for some (WHO, 2018). Among these conditions is Parkinson's disease (PD), the second most common age-related neurogenerative disorder (Wong et al., 2014). Most individuals with PD are diagnosed at the age of 60 or above (Wong et al., 2014) and experience numerous challenges in their everyday lives that impact their participation, including driving impairments (Uc et al., 2007).

Driving is the primary mode of transportation in Western societies (WHO, 2013) and as such, it is the primary enabler of community mobility (Dickerson et al., 2007). Driving allows individuals to get to work, get groceries, attend medical appointments, meet loved ones, and stay connected within their community. Thus, driving is strongly associated with independence, mental health, and quality of life (Dickerson et al., 2007). However, road safety is a growing concern, with road traffic injuries being the eighth leading cause of deaths worldwide (WHO, 2013) and the only accidental cause in the top ten (WHO, 2013). In fact, it is estimated that deaths due to road traffic injuries will be the fifth leading cause of deaths by 2030 (WHO, 2013). Moreover, 20 to 50 million people worldwide experience injuries due to driving collisions every year (WHO, 2013). In Canada alone, there were a reported 1,922 fatalities and 152,847 total injuries due to motor vehicle traffic collision in 2018 (Transport Canada, 2020). These statistics make fitness to drive and road safety critical area for research, especially among vulnerable populations such as those with PD.

Persons living with PD commonly experience a decline in cognitive, motor, and visual functions as the condition progresses, which in turn can lead to driving becoming increasingly challenging (Uc et al., 2007; Wong et al., 2014). Given these symptoms, individuals with PD are a higher risk population for impaired fitness to drive (Wood et al., 2005). For example, cognitive impairment can make maintaining attention and decision making on the road more difficult (Uc et al., 2007). Drivers with PD also make more driving errors when compared to healthy controls and have difficulty controlling a vehicle smoothly (Wood et al., 2005). Individuals with PD are also more likely to fail an on-road assessment compared to healthy age-controlled peers (Classen et al., 2011). However, the emergence of advanced driving assistance systems (ADAS) has the potential to help drivers with PD stay on the road longer and safer than currently possible.

ADAS are a form of vehicle automation that assists drivers by automating certain aspects of the driving task such as speed control, collision avoidance, or lane changes (Alvarez, 2017). ADAS are primarily designed for routine drivers, but these features have the potential to benefit drivers of all backgrounds, including at risk drivers who are learning to drive, older drivers or medically at-risk drivers (Alvarez, 2017). As such, ADAS constitute a potential intervention tool to improve the on-road performance of individuals with PD (Alvarez, 2017).

To date, there are limited studies exploring the effectiveness of ADAS among populations with neurological disorders, as this is a relatively new technology and older adults are often excluded from technology design processes within consumer mass markets (Classen & Alvarez, 2020). However, given that technology acceptance is a critical element of sustained technology effectiveness (Lee et al., 2003), exploring the acceptance of ADAS among drivers with PD is necessary to establish whether ADAS presents an adequate approach to improved driving performance in this population. Investigating drivers’ perceptions and attitudes towards ADAS can lead to determining their behavioural intention to use ADAS (Davis, 1989) and the need for strategies that promote inclusion of this population in the development of accessible driver technologies. If their attitude and perception lean favourably towards intention to use, there can be increased uptake and use of ADAS in routine driving, as well as increased confidence among drivers with PD. This, in turn, may result in increased community participation, reduced vehicle collisions, and a safer driving environment (Alvarez, 2017). A safer driving environment is where drivers are being safe and responsible on the road, which includes driving practices that help traffic move safely and with minimal vehicle collisions (Ministry of Transportation, 2019). With the unprecedented pace of population aging and the growing burden of road traffic fatalities and severe injuries, vehicle automation technologies have the potential to provide viable interventions for those at risk. Therefore, research investigating their potential uptake by at-risk populations is essential (WHO, 2013). As such, this thesis presents the results of a survey study exploring the perception and attitudes of Canadians living with Parkinson’s disease towards using ADAS.

Chapter 2

2 Background

2.1 Parkinson’s Disease

PD is the second most common neurodegenerative disorder (Grimes et al., 2012) after Alzheimer’s disease (Wong et al., 2014). PD is characterized by the loss of dopamine, a neurotransmitter involved in the coordination of body movements and produced in the substantia nigra (Patel & Chang, 2014). Common clinical manifestations of PD include decline in motor function such as bradykinesia, rigidity, tremor and postural instability (Grimes et al., 2012). These symptoms tend to be asymmetrical and more evident on one side of the body compared to the other (Patel & Chang, 2014).

Alongside motor function decline, individuals with PD experience neuropsychiatric symptoms. These symptoms are increasingly challenging to treat as the disease progresses and contribute negatively to disability and quality of life (Grimes et al., 2012). For example, PD can impact an individual’s mental health and that of their caregiver. It has been reported that up to 50% of individuals with PD experience depression (Grimes et al., 2012). Up to 50% of individuals with PD also experience psychotic features such as visual hallucinations, auditory hallucinations and paranoia. These psychotic features generally continue throughout the course of the condition once it begins (Grimes et al., 2012). Dementia is also common among individuals with PD, and frequency increases with disease duration (Grimes et al., 2012). Cognitive impairments in PD can also impact memory, concentration, visuospatial skills, language ability and ability to make decisions (Watson & Leverenz, 2010).

Individuals with PD also experience other challenges including sleep disorders and autonomic disfunction (Grimes et al., 2012). Among sleep disorders, 60% of people with PD experience insomnia, 35% experience rapid eye movement (REM) sleep behaviour disorder, and 40% experience excessive daytime sleepiness, a safety hazard if the individual falls asleep while working, walking or driving (Grimes et al., 2012).

Autonomic dysfunction is prevalent in between 14% to 80% of all individuals with PD including weight loss, urinary dysfunction, constipation, dysphagia, excessive salivation, excessive sweating and orthostatic hypotension (Grimes et al., 2012).

Though treatment for PD requires a multidisciplinary approach, the treatment is predominantly pharmacological, with a primary focus on motor symptoms which are treated with levodopa taken in combination with carbidopa (Grimes et al., 2012). Levodopa converts to dopamine once it crosses the blood to brain barrier to replenish the loss of dopamine (Patel & Chang, 2014). Carbidopa inhibits the breakdown of levodopa before it reaches the brain (Patel & Chang, 2014). Medication for PD needs to be individually adjusted to each individual's needs and challenges can arise including "wearing off", where the effect of levodopa becomes shorter with time, or "freezing", where the levodopa may not show any beneficial effect for periods of time (Patel & Chang, 2014). Other intervention approaches for PD include neurosurgical procedures, physical exercise training, music therapy, occupational therapy, physiotherapy, speech therapy and dietician services to maintain healthy diet (Grimes et al., 2012).

There are an estimated 100,000 Canadians living with PD (Patel & Chang, 2014). Although PD occurs in both women and men, it is more prevalent among men. For example, 3.34% of men compared to 1.67% women in the Canadian household population aged 45 or older have PD (Wong et al., 2014). In addition, 19.1% of men compared to 11.1% of women among the Canadian institutional population aged 45 or older have PD (Wong et al., 2014). As an age-related condition, PD prevalence increases with age. In fact, 85% of individuals who are diagnosed with the condition are above 65 years of age (Patel & Chang, 2014). Among Canadians with PD, individuals first experienced symptoms of Parkinson's at the mean age of 64.4 years old (Wong et al., 2014). The diagnosis for the disease took approximately 1.9 years at a mean age of 66.2 (Wong et al., 2014).

Statistics Canada reported that 84% of individuals with PD received informal assistance from family, friends or neighbours (Wong et al., 2014). They required informal assistance in various domains including emotional support (77%), transportation (70%), meal delivery and preparation (64%), personal care (57%) and medical care (39%) (Wong et al., 2014). Furthermore, 61% of people with the disease reported out of pocket expenses due to medication, assistive devices, therapy and home care in the past 12 months (Wong et al., 2014). From added stress on personal relationships and challenges in employment, to difficulties in completing routine tasks, PD can affect every aspect of daily life (Grimes et al., 2012).

2.2 Driving Experiences

Individuals with PD identify driving as an activity of great significance to them (Holmes et al., 2019; Rizzo, 2011; Turner et al., 2016). In fact, driving has been described by individuals with PD as not only being enjoyable but associated with one's identity and freedom (Holmes et al., 2019). For example, in a case study by Rizzo (2011), an individual with PD expressed that not driving was a dramatic life change that required many lifestyle changes such as increased difficulty getting from place to place or burdening others for a ride to different places (Rizzo, 2011). Individuals with PD have described the impact of both physical symptoms and medications on their driving (Holmes et al., 2019). Symptoms such as lack of concentration, freezing or shaking limbs and medication timing were a cause of stress when driving (Holmes et al., 2019). Moreover, 8% of drivers with PD experience sudden sleep attacks while driving (Meindorfner et al., 2005). In addition to physical symptoms, drivers with PD felt their cognitive skills, when driving, are also affected. Once diagnosed with PD, many drivers have experienced increased anxiety and a decrease in confidence on the road (Turner et al., 2016). Anxiety also created concern on how an individual with PD will be perceived by others in public settings, which leads to feelings of anxiety or discomfort using services such as public transportation (Turner et al., 2016). Many individuals were worried about losing their independence as reduced driving would place added stress on family and friends in their life (Holmes et al., 2019; Rizzo, 2011). As such, driving cessation is a primary concern for people with PD.

Many individuals with Parkinson's report anxiety, worry and avoidance regarding driving cessation specifically (Turner et al., 2016). These include concerns about losing opportunities to do essential activities such as attending medical appointments and loss of social engagement opportunities within the community (Turner et al., 2016). In addition, many individuals were not actively planning and preparing for driving cessation, especially those living in metropolitan areas (Turner et al., 2016). Furthermore, neurologists have expressed discomfort discussing the sensitive topic of driving and driving cessation with their patients with PD (Schwartz et al. 2018). Overall, neurologists exhibit a tendency to overestimate the driving ability of drivers with PD, similar to drivers themselves (Classen & Alvarez, 2015; Heikkila et al., 1998). In fact, caregivers' risk impressions, when compared to physicians and drivers themselves, have been documented to have adequate predictive validity on drivers with PD's on-road outcomes (Classen & Alvarez, 2015).

Driving cessation is a common experience among those living with PD. One study found that there are higher rates of driving cessation among drivers with PD (17.6%) compared to a control group (3.1%) two years after the study had started (Uc et al., 2011). Women were also found to quit driving earlier than men (Crizzle et al., 2013). The added stress on personal relationships, driving cessation and community mobility make it evident as to why driving is of such great significance among drivers with PD.

2.3 Self-Regulation of Driving Behaviour

Numerous studies have compared the self-regulation of driving behaviours of individuals with PD to healthy controls. Self-regulation of driving behaviours involves changes in the amount, time, location and kind of driving individuals display to reduce risk and preserve safety (Transportation Research Board, 2016). The kind of driving can include avoiding nighttime driving, avoiding rush hour, driving at slower speeds, avoiding highways, and no passengers.

Previous research has documented how drivers with PD perceive themselves as experiencing declines in driving ability, with one study reporting that 62% of the drivers with PD drove with limitations (Meindorfner et al., 2005). For example, drivers with PD tend to drive shorter distances (M=7,669 km) when compared to healthy controls (M=11,584 km) over the course of a year (Meindorfner et al., 2005; Stolwyk et al., 2015).

However, drivers tend to underestimate the distance they drove even though it is less than healthy controls (Crizzle et al., 2013).

Drivers with PD described unfamiliar situations, in-car distractions, low visibility conditions, and long journeys as challenges while driving (Stolwyk et al., 2015). To overcome these challenges, individuals reported modified driving behaviours such as avoiding certain areas like downtown due to high traffic (Holmes et al., 2019). Driving behaviors such as scanning the environment are harder as drivers are able to identify fewer landmarks and traffic signs while driving compared to controls (Uc et al., 2006). Drivers also reported compensatory driving behaviours such as taking more breaks while driving, reduced driving in the dark and in the winter (Holmes et al., 2019). The control group in one study displayed better cognitive scores than individuals with PD, which was associated with reduced driving is risky situations such as during rush hour or inclement weather conditions. If drivers with PD drive more in these risky situations, it places increased risk on their own safety and other drivers on the road (Crizzle et al., 2013). In addition, females were found to drive more cautiously than males and avoided night driving, rush hour, heavy traffic and driving in the rain (Crizzle et al., 2013).

Individuals with PD also drive slower at T junctions compared to control participants (Cordell et al., 2008) and experience difficulties with driving behaviours including maintaining speed, controlling the steering wheel, using the side and rear mirrors, and performing two driving tasks simultaneously (Cordell et al., 2008). Drivers with PD also tend to reduce speed when driving near traffic signals and curves (Stolwyk et al., 2006). They can also have difficulty multitasking as drivers prolonged completing a concurrent task compared to controls (Stolwyk et al., 2006). When given concurrent tasks to perform while driving, individuals with PD also drove more towards the centre of the road (Stolwyk et al., 2006).

One study examined the effect of external cue validity on driving performance (Scally et al., 2011). The study had three cues preceding a red traffic signal during the driving simulation: valid cue (correct signal prediction), invalid cue (incorrect signal prediction) and no cue. The results found that individuals with PD used the brake significantly later in comparison to the controls for the invalid cue and no cue, which supported previous findings of reduced speed near traffic signals (Scalley et al., 2011). However, the braking performance was comparable to controls with a valid cue which highlights how drivers with PD struggle with certain driving behaviours, such as braking, without appropriate external cues (Scally et al., 2011). Individuals with PD were found to display slower reaction, response and movement time for the brake test compared to control participants (Crizzle et al., 2013). However, worst response and movement times were associated with increased highway driving, which is concerning as these factors can place drivers with PD at an increased risk for adverse events on the highway (Crizzle et al., 2013). Overall, drivers with PD displayed more conservative behaviour as they drove with more caution and less competency than control drivers.

2.4 Driving Assessment Performance

Previous studies have looked at the on-road driving performance of drivers with PD. These on-road assessments are helpful to indicate increased risk for driving impairment or crash involvement among this population (Transportation Research Board, 2016). Individuals with PD make increased on road errors, where one study reported 53% of drivers with PD made incorrect turns compared to 21.1% among controls during an on-road assessment (Uc et al., 2007). 15.8% of drivers with PD got lost compared to 2.0% of the controls (Uc et al., 2007). In addition, 84.2% of drivers with PD displayed at-fault safety errors in comparison to 46.7% of the controls (Uc et al., 2007). Another study supported these findings, where drivers with PD displayed an average of 41.6 ± 14.6 errors in comparison to 32.9 ± 12.3 errors that neurotypical controls (Uc et al., 2009). Similarly, the study found drivers with PD displayed an average of 16.5 ± 10.4 errors in lane observance compared to 11.6 ± 7.9 errors among controls and an average of 4.9 ± 2.2 stop sign errors compared to 4.2 ± 2.1 errors among controls on the road assessment. Individuals with PD also took longer to learn and complete the driving route in the study (Uc et al., 2007).

Overall, individuals with PD display poorer performance on on-road assessments, with one study reported 41% of drivers with PD failed driving assessments compared to 9% for neurotypical controls (Classen et al., 2014). Failing on road assessments has been found to be associated with difficulties in executive, motor, visual and visuospatial functions (Devos et al., 2013). In addition to finding on on-road assessments more challenging, drivers with PD are involved in increased vehicle collisions. Among drivers with PD, worse postural stability and previous history of driving citations were associated with vehicle collisions (Uc et al., 2011). Another study investigating collision prevalence among individuals with PD who had a driver's licence, 15% of the participants were involved in a collision in the previous 5 years (Meindorfner et al., 2005). Moreover, 11% of the participants were found to be at-fault in at least one collision in the 5-year period. Sudden onset of sleep and daytime sleepiness among drivers with PD was strongly associated with risk of collisions and traffic safety (Meindorfner et al., 2005). Decreased performance during on-road assessments places all drivers on the road at risk and would therefore require an appropriate intervention to increase road safety.

2.5 Advanced Driver Assistance Systems

ADAS are a type of vehicle automation technology that assists drivers with the control of their vehicle. This technology helps the driver in high risk situations that can affect road safety (Alvarez, 2017). Given the variety and complexity of available technology, two taxonomies were originally established to define and organize these vehicle features. The first is the Society of Automotive Engineers (SAE) taxonomy which has six levels of automation ranging from Level 0 (no automation) to Level 5 (full automation) (SAE, 2018). The SAE taxonomy focuses on aspects of the driving task that are assumed by either the technology or the driver. The second taxonomy was the National Highway Traffic Safety Administration (NHTSA)'s taxonomy, which for the purpose of consistency in taxonomy usage later adopted the SAE taxonomy as outlined in Table 1 (NHTSA, 2017; NHTSA, 2020; Alvarez, 2017). As such, the SAE taxonomy levels are used in this thesis to emphasize the automation capabilities of vehicle technology for the driver and the way in which their perceptions and attitudes can influence technology use. SAE Levels 0, 1 and 2 refer to ADAS features and constitute information systems or partial vehicle automation. As such, this thesis centers on these three taxonomy levels which are currently commercially available (Alvarez, 2017). In fact, Global market research company Ipsos reported that approximately 12% of Canadians are already equipped with ADAS features in their vehicles as of 2019 (Collision Repair Magazine, 2019). Table 2 outlines out each ADAS feature included in this study with its description (NHTSA, 2020).

Table 1. SAE Levels of Automation (Alvarez, 2017; Classen & Alvarez, 2020; NHTSA, 2020).

	Description	**Example**
Level O- No Automation	The driver performs all of the driving tasks.	Blind spot detector- Monitors and signals a warning to driver of any vehicles in the driver's blind spot
Level 1- Driver Assistance	The vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Adaptive cruise control- Maintains speed and distance from the lead vehicle
Level 2- Partial Automation	The vehicle has combined automated functions such as steering and accelerating/braking, but the driver must remain engaged with the driving task and monitor the road at all times.	Park assist- performs the steering and accelerating/braking function for vehicles to park
Level 3- Conditional Automation	The driver is a necessity but is not required to monitor the road. The driver must be prepared to take control of the vehicle at any time with notice.	Traffic jam assist- activated during traffic jams to maintain vehicle speed, position and distance from the vehicle ahead of it
Level 4- High Automation	The vehicle is capable of performing all the driving functions under certain conditions, where the driver may have the option to control the vehicle.	Highway pilot- fully operates and controls the vehicle on the highway

Level 5- Full Automation	The vehicle is capable of performing all the driving functions in all conditions, where the driver may have the option to control the vehicle.	Autonomous vehicle- performs all driving functions and requires no driver

Note: The descriptions for each level are those provided by the SAE taxonomy from the NHTSA website (NHTSA, 2020).

Table 2. ADAS features and description of each feature.

ADAS Feature	**Description**
Park assist	Car feature that automatically steers and moves the vehicle into parking spot
Lane-keeping assist	Car feature that corrects the vehicle position if drifting towards the incoming lane
Lane-centering control	Car feature that maintains the vehicle in the center of the lane
Adaptive cruise control	Car feature that maintains speed and distance from the lead vehicle
Pedestrian automatic emergency braking	Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected
Forward collision warning system	Car feature that automatically apply the brakes if vehicle is at risk of a potential collision
Intersection assistant	Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
Blind spot detector	Car feature that warns if a vehicle is in the blind spot
Automotive night vision	Car feature that increases road visibility in darkness/night beyond the reach of vehicle’s headlights

ADAS can offer many benefits in terms of efficiency, safety and mobility. For example, the adequate use of ADAS can improve traffic flow, also reducing the environmental impact of vehicles on climate change. Moreover, given that human error causes 94% of serious crashes, ADAS have the potential to improve road safety for all drivers, including those medically at-risk (Dotzauer et al., 2015; Faber & van Lierop, 2020; NHTSA, 2020; Reimer et al., 2010).

Despite the potential benefits of ADAS, drivers report concerns and issues of trust in relation to their use. One study exploring the perceived benefits and concerns towards ADAS reported that participants, who varied in age between 25 to 85, expressed concern for older drivers who may find this technology overwhelming. Participants also worried that ADAS would make drivers be more prone to getting distracted or develop poor driving habits (Pradhan et al., 2018). Similarly, another study found there was a lack of trust towards automated vehicles due to concerns of it failing and not having assistance if the system breaks down. Some participants expressed they would prefer to have complete control over their vehicle (Faber & van Lierop, 2020). However, the same study showed that many of the participants views on trusting automated vehicles were changed through discussion on the topic after one participant noted that this technology would only be legal if it is less likely to cause collisions than a human (Faber & van Lierop, 2020).

In addition, other recent studies have documented the benefits of exploring and addressing ADAS information and training needs among drivers. For example, Abraham and colleagues (2017) found that training on using ADAS increased confidence using the system and that participants found that the safety benefits outweighed drawbacks such as participants feeling as though there were alerts from the technology while driving that they sometimes felt wasn’t necessary. Another study investigated if ADAS reduced driver stress by specifically looking at the park assist technology (Reimer et al., 2010). Participants initially reported that it would be unlikely that ADAS reduced parking stress prior to learning how to use the park assist feature. However, with training, participants reported lower stress levels when using the ADAS feature compared to without it. This was further supported by an average decreased heart rate of 12.6 beats per minute among participants while using ADAS (Reimer et al., 2010). Another study with individuals with PD found that the use of ADAS had improved driving performance such as speed control and time headway. However, once ADAS wasn't present, a deterioration in speed measure was found among drivers with PD (Dotzauer et al., 2015).

The Michon Model offers a helpful classification of driving performance components, which can enable a better understanding of the impact of ADAS on the driving performance of drivers with PD. The Michon model classifies driving behaviour into three levels (van Zomeren et al., 1987). Strategic level driving behaviours are defined as those pertaining to the general planning of a trip such as trip goals and route (Transportation Research Board, 2016). These can include the ability to adapt plans while driving such as making expected stops to go to the bathroom or changing a route due to a vehicle crash. Tactical level driving behaviors are those by which the driver executes maneuver control over a vehicle while completing a goal directed trip in response to current driving conditions (Transportation Research Board, 2016). These behaviours tend to be learned and practiced and include obstacle avoidance, obeying traffic signals, and turning. Operational level driving behaviors are behaviors that allow the driver to control a vehicle through physical actions such as steering the wheel and pressing the brake (Transportation Research Board, 2016). These behaviours are predominantly automatic and become habitual.

ADAS, SAE Levels 0, 1 and 2, can support tactical and operational driving behaviours. For example, the park assist feature can support operational driving behaviours for drivers with PD by controlling the physical action of steering the wheel (Alvarez, 2017). Similarly, traffic jam assist can support tactical driving behaviours by maneuvering through traffic to avoid collisions (Alvarez, 2017). It is also important to note that older adults have demonstrated a strong interest in using automated vehicles to overcome mobility and accessibility barriers (Faber & van Lierop, 2020). As such, ADAS has the ability to support vulnerable and at-risk drivers, including those with PD, across the lifespan to continue being on the road safely as long as possible (Alvarez, 2017).

2.6 Technology Acceptance

In order for ADAS to be of optimal benefit, it must result in improved driving performance which may not happen if the user is unwilling to accept and use the system (Davis, 1989). Even if a technology serves a valuable purpose, it is at risk of being underused or abandoned if there is limited user acceptance of the technology. To underscore this concern and prompt the inclusion of target consumers in the technology design and use process, several models have been developed to better understand the determinants of technology acceptance. Among these models is the technology acceptance model (TAM) which aims to explain technology use. The model is outlined in Figure 1 (Davis, 1989).

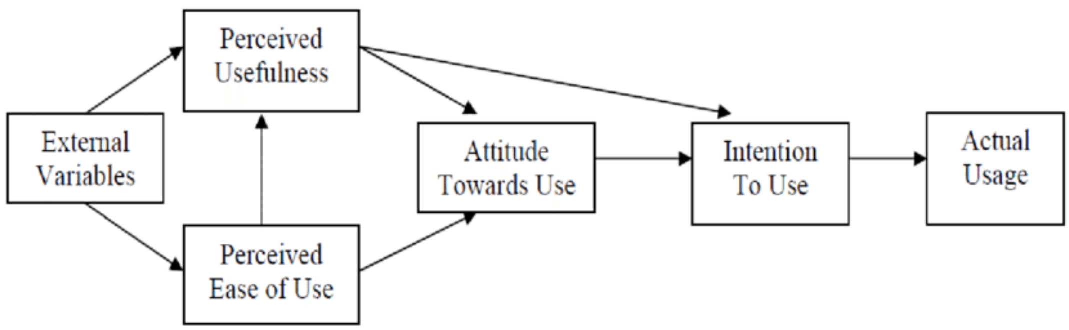

Figure 1. Technology Acceptance Model (Davis, 1989).

The theoretical foundation for TAM is derived from another theory that aims to predict and explain behaviour called the Theory of Reasoned Action (Fishbein & Ajzen, 1975). The TAM describes actual use of a technology as the result of intention to use, which in turn is impacted by attitudes towards use. The model outlines two determinants of attitude towards use. The first is perceived usefulness, which is the degree to which an individual believes using a technology will help them perform the activity better (Davis, 1989). The second is perceived ease of use, which is the degree to which an individual believes that using a technology would be free of effort (Davis, 1989).

The model then explores attitude towards using a technology, where attitude is defined as the evaluation of a behaviour along a dimension of favour or disfavour (Ajzen & Fishbein, 2000). Both attitude and perception lead to forming behaviour intention, which then leads to actual use for the technology (Ajzen & Fishbein, 2000).

If ADAS can assist drivers with PD to remain on the road for longer and safer than currently possible, an approach that several research teams are currently exploring (Dotzauer et al., 2015; Reimer et al., 2010), then understanding their perceptions and attitudes is essential to improve uptake. If drivers with PD perceive ADAS as being beneficial and have a favourable attitude towards it, they are more likely to intend to use the technology which will result in more drivers using ADAS on the road. Beyond receiving medical care, individuals with PD require support to engage in occupations that are meaningful to them (Grimes et al., 2012). Having a better understanding of perceptions and attitudes towards ADAS will not only help maintain quality of life and community mobility among individuals with PD but can also increase knowledge and education to improve their road safety.

2.7 COVID-19 Global Pandemic

The planning of this study and data collection were both conducted during the COVID-19 pandemic, including the logistical challenges the pandemic posed to all research while also having to manage stressors of the global pandemic. As a result, this study ensured that all methods were consistent with public health guidelines while taking into careful consideration that individuals with PD are a high-risk population.

Chapter 3

3 Objectives

This study aimed to explore the perception and attitudes of using Advanced Driver Assistance Systems (ADAS) among Canadians living with PD. This will be achieved through three specific aims:

1. To identify the perception and attitude of Canadians living with PD towards ADAS. Rationale: ADAS are increasingly prevalent commercially and have the potential to increase road safety for everyone, including at risk populations. If perception and attitude are adequately understood, this can inform designers and manufacturers to develop new technology design ideas accordingly and optimize technology design. Moreover, this would provide opportunities to develop evidence-based educational strategies that can provide drivers with PD with the necessary tools to make purchasing or use decisions. For example, vendors can use this evidence to partner with people living with PD to educate on the use and benefits of ADAS for this population.
2. To examine if the perception and attitudes of drivers with PD towards ADAS is a determinant of intention to use ADAS in this population. Rationale: If more individuals intend to use ADAS, then healthcare professionals and researchers can develop client-centered interventions to assist drivers with PD to incorporate these technologies into their driving. In addition, drivers using ADAS would benefit by added driving confidence, increased number of years to drive across the lifespan, improved community mobility and increased quality of life if their concerns and perceptions around ADAS were adequately understood and addressed.
3. To examine if prior experience with ADAS predicts intention to use it. Rationale: If individuals who have prior experience using ADAS intend to use it, then vendors, government programs and community programs can provide opportunities to encourage increased exposure to ADAS among individuals with PD through education on ADAS and opportunities to trial use vehicles with ADAS. Such opportunities will increase the number of drivers that intend to use ADAS and enable increased road safety for everyone on the road across the lifespan.

Chapter 4

4 Methods

4.1 Study Design

This is a quantitative observational study that used an online survey to gather data. Survey research is used to collect information for a sample of individuals and allows for various methods to recruit participants (Ponto, 2015). In addition, survey research provides an opportunity to ask different types of questions from multiple choice to open ended questions depending on the goal of the research. Survey research can gather information from a large population in a relatively quick time period (Ponto, 2015). Observational studies can study several outcomes and are good for studying rare exposures (Song & Chung, 2010).

Ethics approval for this study was obtained from the Health Sciences Research Ethics Board (HSREB) at Western University. The participants provided informed explicit consent to participate in this study by clicking: “I consent to participating in this study” on the consent page at the beginning of the online survey. The survey questionnaire used standardized outcome measures from the technology acceptance model to explore perceptions and attitudes towards ADAS among individuals with PD (Davis, 1989).

4.2 Participants

Participants were eligible to participate in the study if they: (1) self-reportedly had a confirmed diagnosis of PD, (2) had a valid provincial driver’s license, (3) resided in Canada, (4) were self reportedly proficient in English and (5) were 18 years old of age or older. Participants were ineligible to participate in the study if they had a learner’s driver’s licence.

The recruitment procedure for participants involved sharing the link of the online Qualtrics survey through social media platforms including the lab’s Facebook and Twitter. In addition, organizations such as Parkinson Canada, Parkinson Society

Southwestern Ontario, Parkinson Quebec, Parkinson Society British Columbia and Parkinson Association of Alberta were contacted to promote and share the survey link. The organizations were also requested to share the survey in their e-newsletters and email communications with people with PD in their network. The participants were given an opportunity to enter an optional virtual draw at the end of the survey to win one of eight Amazon gift cards valued at $25 each as a token of appreciation for their time.

4.3 Sample Size

G*Power 3.1 Software was used to calculate sample size for this study (Faul et al., 2009). The a-priori sample size was conducted for regression analyses with six predictors, an alpha of 0.05, and a power of 95% to detect a medium effect of 0.15, with a total of 146 participants. Given the established theoretical and empirical relationship between perceived ease of use and perceived usefulness with intention to use, a conventional medium effect was chosen. A large effect was not considered optimal for a priori analysis given the novel application of these concepts to the study of ADAS in individuals with PD. Based on this calculation, the sample size required for this study was 146 participants.

4.4 Data Collection

The study used an online survey for data collection to explore the perceptions and attitudes towards ADAS among drivers with PD. The online survey was made using an institutionalized licence of Qualtrics through Western University. Qualtrics prevents multiple submissions and encrypts transmitted Internet data which ensures data security (Qualtrics, 2015). The downloaded data from the survey was stored on the lab secure server and was compliant with the general data protection policy.

An online survey was a feasible and cost-effective way to reach a large number of participants across the country, including those living in remote areas. In addition, an online survey was a relatively easy method to gather a broad range of data on numerous variables while allowing the participants to remain anonymous. Data collection for this study was completed in December 2021.

4.5 Procedure

Upon accessing the survey link, participants were presented with a series of question to determine study eligibility. If criteria were met for inclusion, participants were automatically taken to the letter of information and consent page. This page provided detailed information about the study and provided an opportunity for participants to provide explicit consent to participate. If the participant provided consent, the site took them to the survey landing page that contained demographic questions. The following section provided information related to what ADAS are and explored the participants' rating of pre-survey knowledge regarding ADAS. Next, participants were presented with a section providing detailed information regarding ADAS including definitions, a list of common ADAS features, and a link to NHTSA to learn more about ADAS. Then, a series of questions explored the participants' understanding of ADAS after being provided this information. The second section on this page asked the participant questions about their prior experiences with ADAS.

Once all the questions on this page were completed, the participants were taken to the next page to complete three brief standardized outcome measures developed as an extension of the technology acceptance model including: perception, attitude and behavioural intention to use ADAS (Ajzen & Fishbein, 1980; Ajzen & Fishbein, 2000; Davis, 1989). In addition to the standardized outcome measures, participants were asked questions about which ADAS features they found most/least useful and which features they found hardest/easiest to use. A statement at the end of this page informed the participant that they had reached the end of the survey.

Upon completion of the survey, the participant was directed to another page, separate from the study data, where they were provided with an opportunity to enter their email to participate in an optional virtual draw to win one of eight Amazon gift cards valued at $25 each. The e-mail provided for this draw was not connected to the data to maintain participant anonymity. A virtual draw was conducted once all data collection was complete and the winners were contacted through the provided e-mail.

4.6 Outcome Measures

4.6.1 Demographic Questions

The survey questionnaire first asked demographic questions including as gender, age, ethnicity, education level, province of residency and occupation. Questions regarding ethnicity and province of residency were based on the Statistic Canada Census questions for 2021 (Statistics Canada, 2020).

4.6.2 Current Knowledge of ADAS and Prior Experiences using ADAS Questions

This section began by asking participants three questions related to their understanding of ADAS features and how they would self-rate their ADAS knowledge. The survey questionnaire was designed with the assumption that participants have varied knowledge on ADAS. As a result, this section then provided information regarding what ADAS are and examples of common ADAS features with a short description of each feature. Participants were given the opportunity to learn more about ADAS through the attached NHTSA link in this section, if interested. To ensure participants adequately understood what ADAS were, they were then asked four more questions related to their understanding of ADAS features and how they would self-rate their ADAS knowledge after being given information about it.

To explore Specific Aim 3, the second section asked participants about their experiences using ADAS. There were questions exploring previous experiences participants had using ADAS, including which ADAS features they had been exposed to if any, if they owned a vehicle with ADAS features, which ADAS features their vehicle had and how often they used ADAS.

4.6.3 Technology Acceptance Questions

This part of the study questionnaire used standardized outcome measures from the Technology Acceptance Model developed by Davis (Davis, 1989). All standardized outcome measures for perception, attitude and behavioural intention to use, utilized a 7-

point Likert scale, as per Davis and Azjen's questionnaires (Ajzen & Fishbein, 1980; Davis, 1989). The descriptor for each item of perception, attitude, and behavioural intention to use is outlined in Table 3.

- Perceived usefulness and perceived ease of use: Davis developed a standardized outcome measure for both perceived usefulness and perceived ease of use from the Technology Acceptance Model, where both parts consist of six items each (Davis, 1989). However, five items were used for perceived usefulness in this study. One perceived usefulness item related to increasing productivity was not used as it was not applicable in the context of using ADAS. A composite score was used to represent each of the items for perceived usefulness in the study. Following the five items perceived usefulness items, participants were asked two questions about which ADAS features are most and least useful to them. Similarly, a composite score was also used to represent each of the items for perceived ease of use. Following the six perceived ease of use items, participants were asked two questions about which ADAS features were easiest and hardest for them to use.
- Attitude and behavioural intention to use: Azjen developed a standardized outcome measure for both attitude and behavioural intention to use where attitude consists of four items and behavioral intention to use consists of one item (Ajzen & Fishbein, 1980). While the standardized outcome measure for behavioral intention to use has one item, I added a second item for behavioural intention to use ADAS. This second item explored if the participant intended to purchase a vehicle with ADAS features in the future in addition to the first item about if the participant intends to use ADAS in the next year.

Table 3. Items for perceived usefulness, perceived ease of use and intention to use.

	Item
Perceived usefulness	1. Using ADAS in my driving would enable me to accomplish tasks more quickly. 2. Using ADAS would improve my driving performance. 3. Using ADAS would enhance my effectiveness on driving. 4. Using ADAS would make it easier to do my driving. 5. I would find ADAS useful in my driving.
Perceived ease of use	1. Learning to operate ADAS would be easy for me. 2. I would find it easy to get ADAS to do what I want it to do. 3. My interaction with ADAS would be clear and understandable. 4. I would find ADAS to be flexible to interact with. 5. It would be easy for me to become skillful at using ADAS. 6. I would find ADAS easy to use.
Attitude	1. Using ADAS in my driving would be 1= Extremely beneficial 2= Quite beneficial 3= Slightly beneficial 4= Neither beneficial nor harmful 5= Slightly harmful 6= Quite harmful 7= Extremely harmful 2. Using ADAS in my driving would be 1= Extremely good 2= Quite good 3= Slightly good 4= Neither good nor bad 5= Slightly bad 6= Quite bad 7= Extremely bad 3. Using ADAS in my driving would be 1= Extremely rewarding 2= Quite rewarding 3= Slightly rewarding 4= Not rewarding nor punishing 5= Slightly punishing

	6= Quite punishing 7= Extremely punishing 4. Using ADAS in my driving would be 1= Extremely pleasant 2= Quite pleasant 3= Slightly pleasant 4= Not pleasant not unpleasant 5= Slightly unpleasant 6= Quite unpleasant 7= Extremely unpleasant
Intention To Use	1. I intend to use ADAS in the next year. 2. If I purchase a vehicle in the future, I intend to purchase a vehicle with ADAS features in it.

Note. Items for perceived usefulness, perceived ease of use and intention to use have the following 7-point Likert scale: 1= extremely likely, 2= quite likely, 3= slightly likely, 4= neither likely nor unlikely, 5= slightly unlikely, 6= quite unlikely, 7= extremely unlikely. The four items for attitude are on a similar 7- point scale outlined in the table.

4.7 Data Analysis

SPSS Statistics (v. 28) was used to analyze all quantitative data gathered from the online survey. Descriptive statistics were used to address the first aim of the study. Percentages and frequency counts were used to describe demographics, prior experiences with ADAS, and perceptions around specific features. The central tendency of data regarding perceived usefulness, perceived ease of use, attitude and behavioural intention to use ADAS was described through the mean of the composite scores for each measure. In addition, dispersion of this data was measured through standard deviation and coefficient of variation.

A composite score was used for each independent variable of perceived usefulness, perceived ease of use, and attitude when entered into the regression analysis. The composite score was calculated via the mean of all items for that predictor as per Boone and Boone (2012).

Ordinal regression analysis was used to address the second and third aims of the study, as the dependent variables are ordinal in nature. Two ordinal regression analyses were used to determine whether perceived usefulness, perceived ease of use, attitude, and prior experience using ADAS were significant predictors of: 1) intention to use ADAS in the next year; and 2) intention to purchase a vehicle with ADAS features in the future. If the assumption for the test of parallel lines was not met for the ordinal regression, then a multinomial regression was used instead (Liang et al., 2020).

The prior experience with ADAS variable was dummy coded, with 1 indicating experience using ADAS and 0 indicating no experience. Experience using ADAS included any prior experience driving or being a passenger in a vehicle with ADAS features, which was the first question under the "Prior Experience with ADAS" section in the survey questionnaire. When conducting the ordinal regression, three values were used for both intention to use items labelled as: likely, neither likely not unlikely and unlikely. Participants who chose extremely likely, quite likely and slightly likely for these were recoded to likely on SPSS. Participants who chose extremely unlikely, quite unlikely and slightly unlikely for these items were recoded to unlikely. This was done to reduce the cells with zero frequencies of dependent variable levels by observed combinations of predictor variable values. Demographic variables such as gender and age were also entered in the regression model.

Chapter 5

5 Results

A total of 202 potential participants engaged with the survey advertisement. Of those, 43 did not meet the eligibility criteria or did not complete the consent form and therefore did not participate in the study. As a result, 159 survey responses were recorded. Five survey responses were missing answers for items regarding perceived usefulness, perceived ease of use, attitude, and/or intention to use, and as such were discarded. One additional response indicated 6 as current age and was therefore discarded. Furthermore, age was removed from data analysis. Unlike every other variable, age was an open text field in the survey. A few participants experienced issues with this open text field. and as such, the data for age was determined to be untrustworthy and was removed from the analysis. After discarding these responses, a total of 153 survey responses were included, which exceeded the calculated sample size of at least 146 responses. As participants were allowed to skip any questions in the survey, any one of these survey responses may have up to 3 items missing. None of these 153 responses were missing data regarding the primary dependent variable of the study which is intention to use.

5.1 Demographics

Out of 153 total survey responses, 152 participants provided information regarding their gender. The options for gender included male, female, I prefer not to answer and you do not have an option that applies to me, I identify as (open field to insert identity). Among the 153 survey responses for gender 92 participants (60.5%) were male and 60 participants (39.5%) were female (Table 4). No participants indicated I prefer not to answer or you do not have an option that applies to me, I identify as (open field to insert identity).

For the question of age of diagnosis of PD, mean age of onset for participants 40 and above was 54.9 years (Table 5). However, for participants under 40 (N= 43), the mean age of diagnosis was 14.8 years. 29 participants (19.0%) reported an age of Parkinson’s diseases diagnosis as 19 and under (Table 4). Presumably this indicates that the question was misunderstood as length of disease duration. However, this cannot be confirmed, and as such, this question was discarded and no conclusion can be drawn.

Among the 153 participants, 92 participants (60.1%) identified their ethnicity as White, 22 participants (14.4%) were South Asian, 15 participants (9.8%) were Black, 14 participants (9.2%) were Latin American, 6 participants (3.9%) were Arab, 5 participants (3.3%) were Chinese, 4 participants (2.6%) were Filipino, 3 participants (2.0%) were West Asian, 2 participants (1.3%) were Southeast Asian, 1 participant (0.7%) was Korean, and 1 participant (0.7%) chose Other to describe their ethnicity (Table 4). The one participant who chose Other identified themself as European.

Among the 153 participants, 18 participants (11.8%) completed less than a high school diploma for their level of education completed, 36 participants (23.5%) completed a high school degree or equivalent, 35 participants (22.9%) completed college, CEGEP or other non-university certificate or diploma, 33 participants (21.6%) completed a Bachelor's degree, 21 participants (13.7%) completed a Master's degree and 10 participants (6.5%) completed a Doctorate degree (Table 4). Among the 152 responses for employment status, 34 participants (22.4%) are employed full-time, 24 participants (15.8%) were employed part-time, 9 participants (5.9%) were unemployed – seeking work opportunities, 9 participants (5.9%) were unemployed – not looking for work, 48 participants (31.6%) were retired, 2 participants (1.3%) were a student, and 26 participants (17.1%) were unable to work (Table 4).

Out of 153 total survey responses, 150 participants provided information regarding their province/territory of residence. Figure 2 illustrates participants province or territory of residence Among the 150 responses, 24 participants (16.6%) resided in Ontario, 21 participants (14.0%) in Alberta, 17 participants (11.3%) in Nova Scotia, 14 participants (9.3%) in Quebec, 14 participants (9.3%) in Nunavut, 11 participants (7.3%) in New Brunswick, 11 participants (7.3%) in Saskatchewan, 9 participants (6.0%) in Prince Edward Island, 9 participants (6.0%) in Newfoundland and Labrador, 8 participants (5.3%) in British Columbia, 8 participants (5.3%) in Manitoba and 4 participants (2.7%) in Northwest Territories (Figure 2 and Table 4).

Table 4. Demographics of survey participants.

Characteristic	**Total Sample** ***n*** **(%)**
Gender (N=152)	
Male	92 (60.5)
Female	60 (39.5)
Parkinson's Disease Diagnosis Age (N= 153)	
19 and under	29 (19.0)
20-29	5 (3.3)
30-39	8 (5.2)
40-49	23 (15.0)
50-59	55 (35.79)
60-69	31 (20.3)
70-79	2 (1.3)
Ethnicity (N= 153)	
White	92 (60.1)
South Asian (e.g., East Indian, Pakistani, Sri Lankan)	22 (14.4)
Chinese	5 (3.3)
Black	15 (9.8)
Filipino	4 (2.6)
Arab	6 (3.9)
Latin American	14 (9.2)
Southeast Asian (e.g., Vietnamese, Cambodian, Laotian, Thai)	2 (1.3)
West Asian (e.g., Iranian, Afghan)	3 (2.0)
Korean	1 (0.7)
Japanese	0 (0)
Other group	1 (0.7)
Level of Education Completed (N= 153)	
Less than a high school diploma	18 (11.8)
High school degree or equivalent	36 (23.5)
College, CEGEP or other non-university certificate or diploma	35 (22.9)
Bachelor's Degree	33 (21.6)
Master's Degree	21 (13.7)
Doctorate degree	10 (6.5)
Employment Status (N= 152)	
Employed Full-Time	34 (22.4)
Employed Part-Time	24 (15.8)
Unemployed – seeking work opportunities	9 (5.9)
Unemployed – not looking for work	9 (5.9)
Retired	48 (31.6)
Student	2 (1.3)

Unable to work	26 (17.1)
Province/Territory of Residence (N= 150)	
Newfoundland and Labrador	9 (6.0)
Prince Edward Island	9 (6.0)
Nova Scotia	17 (11.3)
New Brunswick	11 (7.3)
Quebec	14 (9.3)
Ontario	24 (16.6)
Manitoba	8 (5.3)
Saskatchewan	11 (7.3)
Alberta	21 (14.0)
British Columbia	8 (5.3)
Yukon	0 (0)
Northwest Territories	4 (2.7)
Nunavut	14 (9.3)

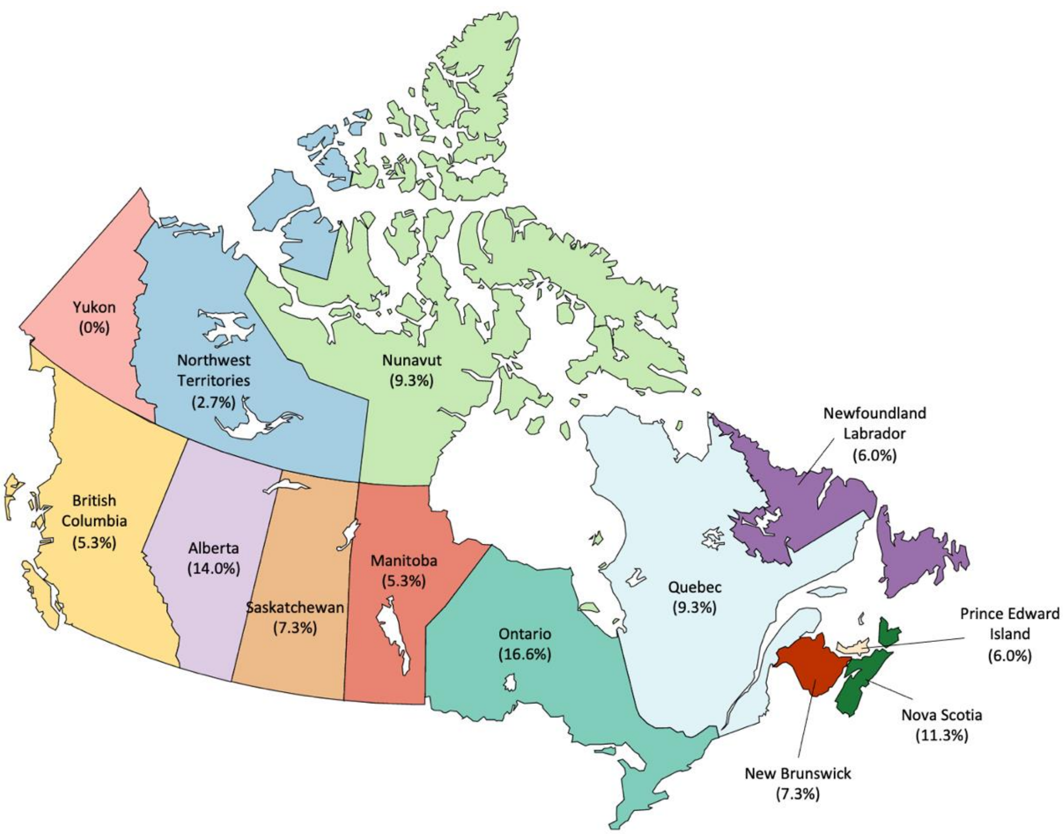

Figure 2. Province/territory of residence by percentage of survey participants.

Table 5. Descriptive statistics for Parkinson's disease age at diagnosis ((N= 152).

Age Group	**Total Sample** ***n*** **(%)**	**Mean**	**Standard Deviation**
Under 40 (Young onset of PD)	43 (25.3)	14.8	11.60
40 and above	115 (74.6)	54.9	7.09

5.2 Participants' Prior Knowledge of ADAS

The study survey included a section that provided information regarding what ADAS are, examples of common ADAS features and an education check. Though the knowledge check at the end of this section is not part of this study's main objectives, it was conducted to ensure all participants have a similar level of understanding about ADAS. Participants were asked to rate their knowledge of ADAS prior to being given ADAS information, where 24 participants (15.7%) rated their knowledge as poor, 60 participants (39.2%) rated it as fair, 46 participants (30.1%) rated it as good, and 23 participants (15.0%) rated it as excellent. After being given ADAS information, the participants rating on ADAS knowledge improved overall as 13 participants (8.5%) rated their knowledge as poor, 48 participants (31.4%) rated it as fair, 57 participants (37.3%) rated it as good, and 35 participants (22.9%) rated it as excellent (Table 6).

Table 6. Self rating of ADAS knowledge (N= 153).

Rating	**Rating prior to being given ADAS information- Total Sample** ***n*** **(%)**	**Rating after being given ADAS information- Total Sample** ***n*** **(%)**
Poor	24 (15.7)	13 (8.5)
Fair	60 (39.2)	48 (31.4)
Good	46 (30.1)	57 (37.3)
Excellent	23 (15.0)	35 (22.9)

5.3 Prior Experiences with ADAS

Among 153 participants, 131 participants (85.6%) had prior experience with ADAS. 54 participants (35.3%) have driven a vehicle with ADAS features and 77 participants (50.3%) have been a passenger in a vehicle with ADAS features. 22 participants (14.4%) had no prior experience with ADAS and have not been a driver or a passenger of a vehicle with ADAS features (Table 7). Among participants who have driven a vehicle with ADAS features, the top three features participants had been exposed to include lane-centering control (42 participants, 27.5%), lane-keeping assist (41 participants, 26.8%) and pedestrian automatic emergency braking (38 participants, 24.8%) (Table 8). 2 participants had been exposed to other features not listed in the survey, which they responded saying it was rear cross path detection and reverse video camera. 50 participants (32.7%) owned a vehicle that had at least one of the ADAS features that they have been exposed to in a vehicle they had driven and 4 participants (2.6%) do not own a vehicle that has at least one of the ADAS features that they have been exposed to (Table 8).

Among participants who owned a vehicle with ADAS features, the top three ADAS features their vehicles had include pedestrian automatic emergency braking (40 participants, 26.1%), forward collision system (37 participants, 24.2%), followed by lane-centering control (37 participants, 24.2%), and blind spot detector (37 participants, 24.2%) tied as features participants had second most in their vehicles and lane-keeping assist (36 participants, 23.5%) as third most (Table 8). 2 participants had other features not listed in the survey, which they responded saying it was rear cross path detection and reverse video camera. 29 participants (19.0%) drove a vehicle with ADAS features daily, 13 participants (8.5%) drove it weekly, 6 participants (3.9%) drove it monthly, 1 participant (0.7%) drove it yearly and 1 participant (0.7%) rarely drove it (Table 8).

The top three ADAS features participants had been exposed to in a vehicle they have been a passenger in included lane-keeping assist (46 participants, 30.1%), park assist (40 participants, 26.1%) and lane-centering control (36 participants, 23.5%) (Table 9). 22 participants (14.3%) had been a passenger in a vehicle with ADAS features daily, 32 participants (20.9%) weekly, 18 participants (11.7%) monthly, 1 participant (0.7%)

yearly and 4 participants (2.6%) had rarely been a passenger in a vehicle with ADAS features (Table 9).

Table 7. Percentages and frequency counts for prior experience with ADAS (N= 153).

Prior Experience Question	**Total Sample** ***n*** **(%)**
Which of the following best describes the participant's experience with ADAS?	
Driven a vehicle with ADAS features	54 (35.3)
Been a passenger in a vehicle with ADAS features	77 (50.3)
Have not been a driver or a passenger of a vehicle with ADAS features	22 (14.4)
Does participant have prior experience with ADAS?	
Yes	131 (85.6)
No	22 (14.4)

Table 8. Percentages and frequency counts for prior experience with ADAS among participants who have driven a vehicle with ADAS features.

Prior Experience Question	**Total Sample** ***n*** **(% of all survey participants)**
To which of the following ADAS features has the participant been exposed to in a vehicle they have driven?	
Park assist	25 (16.3)
Lane-keeping assist	41 (26.8)
Lane-centering control	42 (27.5)
Adaptive cruise control	35 (22.9)
Pedestrian automatic emergency braking	38 (24.8)
Forward collision warning system	35 (22.9)
Intersection assistant	28 (18.3)
Blind spot detector	34 (22.2)
Automotive night vision	27 (17.6)
Other	2 (1.3)
None	0 (0)
Does the participant own a vehicle that has any of the ADAS features that they have been exposed to in a vehicle they have driven?	
Yes	50 (32.7)
No	4 (2.6)
Among participants who own a vehicle with ADAS features, which features does their vehicle have?	
Park assist	26 (17.0)

Lane-keeping assist	36 (23.5)
Lane-centering control	37 (24.2)
Adaptive cruise control	34 (22.2)
Pedestrian automatic emergency braking	40 (26.1)
Forward collision warning system	37 (24.2)
Intersection assistant	34 (22.2)
Blind spot detector	37 (24.2)
Automotive night vision	31 (20.3)
Other	2 (1.3)
None	0 (0)
Among participants who own a vehicle with ADAS features, how often do they drive a vehicle with ADAS features?	
Daily	29 (19.0)
Weekly	13 (8.5)
Monthly	6 (3.9)
Yearly	1 (0.7)
Rarely (used ADAS one or two times in total)	1 (0.7)
Never	0 (0)

Table 9. Percentages and frequency counts for prior experience with ADAS among participants who have been a passenger in a vehicle with ADAS features.

Prior Experience Question	**Total Sample** ***n*** **(% of all survey participants)**
To which of the following ADAS features has the participant been exposed to in a vehicle they have been a passenger in?	
Park assist	40 (26.1)
Lane-keeping assist	46 (30.1)
Lane-centering control	36 (23.5)
Adaptive cruise control	31 (20.3)
Pedestrian automatic emergency braking	34 (22.2)
Forward collision warning system	31 (20.3)
Intersection assistant	29 (19.0)
Blind spot detector	25 (16.3)
Automotive night vision	15 (9.8)
Other	0 (0)
None	0 (0)
How often has the participant been a passenger in a vehicle with ADAS features?	
Daily	22 (14.4)
Weekly	32 (20.9)
Monthly	18 (11.8)
Yearly	1 (0.7)
Rarely (used ADAS one or two times in total)	4 (2.6)
Never	0 (0)

5.4 Technology Acceptance

Table 11 outlines the participant responses for perceived usefulness (*M*= 2.52, *SD*= 0.95), perceived ease of use (*M*= 2.54, *SD*= 0.89), attitude (*M*= 2.94, *SD*= 1.16), first item for intention to use (*M*= 2.63, *SD*= 1.25) and second item for intention to use (M= 2.42, *SD*= 1.15).

The majority of participants responded slightly likely or quite likely for perceived usefulness and perceived ease of use items. The top three ADAS features participants found most useful were lane-centering control (99 participants, 64.7%), lane-keeping assist (86 participants, 56.2%) and forward collision warning system (82 participants, 53.6%) (Table 10). The top three ADAS features participants found least useful include lane-keeping assist (38 participants, 24.8%), park assist (37 participants, 24.2%) and adaptive cruise control (36 participants, 23.5%). Additionally, 29 participants (19.0%) responded that they found none of the ADAS features least useful (Table 10). One participant responded with other for least useful ADAS features but did not specify the feature in their survey response.

The top three ADAS features participants found easiest to use include lane-centering control (88 participants, 57.5%), lane keeping assist (85 participants, 55.6%) and pedestrian automatic emergency braking (80 participants, 52.3%) (Table 10). The top three ADAS features participants found hardest to use include lane-keeping assist (40 participants, 26.1%), intersection assistant (32 participants, 20.9%) followed by lane-centering control (30 participants, 19.6%) and adaptive cruise control (30 participants, 19.6%) tied for third hardest ADAS feature to use. In addition, 34 participants (22.2%) responded that they found none of the ADA features hardest to use (Table 10).

For the attitude items and across four questions, most participants found ADAS either slightly, quite or extremely beneficial, good, rewarding and pleasant. For first item of intention to use, most participants were slightly likely, quite likely or extremely likely to use ADAS next year (Table 10 and 11). For the second intention to use item of if participants purchase a vehicle in the future, most participants were slightly likely, quite likely or extremely likely to purchase a vehicle with ADAS features in it (Table 10 and 11).

Table 10. Percentages and frequency counts for preference of which ADAS features participants find most/least useful and which features participants find hardest/easiest to use (N= 153).

ADAS Feature	**Most Useful ADAS feature- Total Sample *n* (%)**	**Least Useful ADAS feature- Total Sample *n* (%)**	**Easiest ADAS feature to use- Total Sample *n* (%)**	**Hardest ADAS feature to use- Total Sample *n* (%)**
Park assist	61 (39.9)	37 (24.2)	60 (39.2)	27 (17.6)
Lane-keeping assist	86 (56.2)	38 (24.8)	85 (55.6)	40 (26.1)
Lane-centering control	99 (64.7)	34 (22.2)	88 (57.5)	30 (19.6)
Adaptive cruise control	71 (46.4)	36 (23.5)	69 (45.1)	30 (19.6)
Pedestrian automatic emergency braking	79 (51.6)	28 (18.3)	80 (52.3)	25 (16.3)
Forward collision warning system	82 (53.6)	21 (13.7)	67 (43.8)	20 (13.1)
Intersection assistant	71 (46.4)	29 (19.0)	66 (43.1)	32 (20.9)
Blind spot detector	73 (47.7)	28 (18.3)	63 (41.2)	29 (19.0)
Automotive night vision	44 (28.8)	17 (11.1)	44 (28.8)	21 (13.7)
Other	0 (0)	1 (0.7)	0 (0)	0 (0)
None	0 (0)	29 (19.0)	0 (0)	34 (22.2)

Table 11. Descriptive statistics for ADAS technology acceptance questions (N= 153).

	Mean	**Standard Deviation**
Perceived Usefulness	2.52	0.95
Perceived Ease of Use	2.54	0.89
Attitude	2.94	1.16
Intention to Use (first item)	2.63	1.25
Intention to Use (second item)	2.42	1.15

The following independent variables were used as predictors while conducting the ordinal regression analysis: perceived usefulness, perceived ease of use, attitude, prior experience using ADAS and gender. The dependent variables were the two intention to use items.

5.5 Intention to Use ADAS in the Next Year

The first dependent variable was the first intention to use item: “I intend to use ADAS in the next year” (Table 3). The ordinal regression analysis met all assumptions, including no presence of multicollinearity, as well as proportional odds, as assessed by a full likelihood ratio test comparing the fit of proportional odds to a model with varying location parameters, $x^2(5) = 10.39$, $p= 0.065$ (Table 12). The deviance goodness-of-fit test indicated that the model was a good fit to the observed to the observed data for the first intention to use item, $x^2(245) = 138.18$, $p= 1.000$. The final model statistically significantly predicted the dependent variable over and above the intercept-only model for the second intention to use item, $x^2(5) = 60.67$, $p < 0.001$ (Table 12).

As shown in Table 12, only perceived ease of use and previous experience were significant predictors in the model. As such, scoring higher for perceived ease of use also increases the odds that participants will choose a higher score for intention to use ADAS in the next year, with an odds ratio of 2.41 (95% CI, 1.17 to 3.70), $x^2(1) = 11.09$, p< 0.001. In other words, the less an individual perceives using ADAS to be useful, the odds of them disfavouring using ADAS increase over them preferring using ADAS in the next year.

In addition, the lower someone scores in previous experience, the odds that participants will choose a higher score for intention to use ADAS in the next year, with an odds ratio of 1.87 (95% CI, 0.54 to 3.20), $x^2(1)= 6.47$, $p= 0.006$ (Table 12). In other words, having no previous experience, which was dummy coded as 0, increases the odds of participants disfavouring using ADAS increase over them preferring using ADAS in the next year.

Table 12. Parameter estimates for intention to use ADAS in the next year.

				95% Wald CI		Hypothesis Test				95% Wald CI for Exp(B)	
		B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
Threshold	Likely	6.482	1.1083	4.309	8.654	34.202	1	<.001	653.088	74.399	5732.948
	Neither likely nor unlikely	9.215	1.2951	6.677	11.753	50.628	1	<.001	10045.239	793.586	127152.972
	PU	0.073	0.5813	-1.066	1.212	0.016	1	0.9	1.076	0.344	3.361
	PEOU	2.406	0.6571	1.118	3.694	13.404	1	<.001	11.088	3.058	40.197
	Attitude	-0.623	0.3717	-1.351	0.106	2.809	1	0.094	0.536	0.259	1.111
	Gender- Male	-0.154	0.502	-1.138	0.83	0.094	1	0.759	0.857	0.32	2.293
	Gender- Female	0[a]	.	.	.	.	.	.	1	.	.
	Previous Experience- No	1.868	0.6799	0.535	3.2	7.547	1	0.006	6.474	1.708	24.545
	Previous Experience- Yes	0[a]	.	.	.	.	.	.	1	.	.
	Scale	1[a]									

a. Fixed at the displayed value.

5.6 Intention to Purchase a Vehicle with ADAS features in the Future

The second dependant variable was the second item for intention to use: If I purchase a vehicle in the future, I intend to purchase a vehicle with ADAS features in it (Table 3).

However, the ordinal regression analysis violated the assumption of proportional odds. In other words, the regression revealed that each independent variable does not have an identical effect at each cumulative split of the ordinal dependent variable. As a result, a multinomial regression was conducted for the statistical analysis (Liang et al., 2020).

The deviance goodness-of-fit test indicated that the model was a good fit to the observed data for the first intention to use item, $x^2(240) = 84.34$, $p= 1.000$. The final model statistically significantly predicted the dependent variable over and above the intercept-only model for the first intention to use item, $x^2(10) = 90.23$, $p < 0.001$. As shown in Table 13, only perceived usefulness and perceived ease of use were significant predictors in the model.

As such, scoring higher for perceived usefulness increases the odds that participants will choose neither likely nor unlikely over likely for intention to purchase a vehicle with ADAS in the future, b= 6.09, s.e. = 0.71, p= 0.011. The odds ratio indicates that with every unit increase in perceived ease of use, the odds of the participant choosing neither likely nor unlikely over likely increases by a factor of 6.09 (Table 13). In other words, the less an individual perceives ADAS to be useful, the odds of them remaining neutral increase over them preferring purchasing a vehicle with ADAS in the future.

Scoring higher for perceived ease of use increases the odds that participants will choose neither likely nor unlikely over likely for intention to purchase a vehicle with ADAS in the future, b= 4.71, s.e. = 0.75, p= 0.038. The odds ratio indicates that with every unit increase in perceived ease of use, the odds of the participant choosing neither likely nor unlikely over likely increases by a factor of 4.71 (Table 13). In other words, the less an individual perceives using ADAS to be useful, the odds of them remaining neutral increase over them preferring purchasing a vehicle with ADAS in the future.

Scoring higher for perceived ease of use also increases the odds that participants will choose unlikely over likely for intention to use ADAS in the next year, b= 56.02, s.e. = 1.88, p= 0.032. The odds ratio indicates that with every unit increase in perceived ease of use, the odds of the participant choosing unlikely over likely for intention to ADAS in the next year increased by a factor of 56.02 (Table 13). In other words, the less an individual perceives using ADAS to be useful, the odds of them disfavouring using ADAS increase over them preferring purchasing a vehicle with ADAS in the future.

Table 13. Parameter estimates for intention to purchase a vehicle with ADAS features in the future.

								95% CI for Exp(B)	
		B	**Std. Error**	**Wald**	**df**	**Sig.**	**Exp(B)**	**Lower Bound**	**Upper Bound**
Neither likely nor unlikely	**Intercept**	-13.443	3.048	19.447	1	<.001			
	PU	1.807	0.708	6.503	1	0.011	6.089	1.519	24.409
	PEOU	1.55	0.746	4.314	1	0.038	4.712	1.091	20.343
	Attitude	0.355	0.687	0.266	1	0.606	1.426	0.371	5.484
	Gender-Male	0.46	0.757	0.369	1	0.543	1.584	0.359	6.984
	Gender-Female	0^b	.	.	0	.	.	.	.
	Previous Experience-No	-0.873	1.453	0.361	1	0.548	0.418	0.024	7.206
	Previous Experience-Yes	0^b	.	.	0	.	.	.	.
Unlikely	**Intercept**	-14.043	5.481	6.566	1	0.01			
	PU	-2.243	1.556	2.079	1	0.149	0.106	0.005	2.239
	PEOU	4.026	1.875	4.612	1	0.032	56.02	1.421	2207.903
	Attitude	1.38	1.072	1.657	1	0.198	3.974	0.486	32.469

	Gender-Male	-0.499	1.191	0.176	1	0.675	0.607	0.059	6.264
	Gender-Female	0^b	.	.	0	.	.	.	.
	Previous Experience-No	1.983	1.645	1.454	1	0.228	7.263	0.289	182.363
	Previous Experience-Yes	0^b	.	.	0	.	.	.	.

a. The reference category is: Likely.

5.7 End of Survey Commentary

At the end of the survey, participants were given the opportunity to submit any optional commentary. 27 participants provided comments at the end of the survey which were coded based on the framework used by Davies and colleagues (Davies et al, 2016). Among these 27 comments, 25 comments were coded as positive and favourable towards ADAS, while two comments were coded as negative and unfavourable towards ADAS. The two comments where participants expressed concern about ADAS include: “I find the features that depend on cameras and sensors require that these are kept clean, and this can be challenging in the winter with salt and snow” and “A little concerned with the automatic break. Would it result in cars behind having to break quickly/possibly collide with car that had automatic break applied (loss of control?)” Most comments were positive and favoured the use of ADAS. Some examples include: “I think it makes driving much safer for me”, “ADAS feature cars help me a lot and make it easy for me to get around” and “The emergence of ADAS solves the mobility problem of Parkinson's disease”.

Chapter 6

6 Discussion

This study aimed to explore the perceptions and attitude of using ADAS among Canadians living with PD. As the emergence of ADAS features is becoming more prevalent commercially, gaining insight of the perception and attitude of this population can inform manufacturers to optimize technology design. In addition, understanding if perception, attitude, and previous experience is a determinant to use ADAS can lead to developing client-centered interventions to assist drivers with PD to incorporate these technologies into their driving and also would enable increased road safety for everyone on the road across the lifespan. An online survey was used to gather information about the perception and attitudes of using ADAS among this population. The following section will discuss key findings and implications of the results, as well as limitations of the study.

6.1 Key Findings and Implications

6.1.1 Demographics

There were more male study participants (60.5%) than female (39.5%) in the study. This is not surprising as PD is more prevalent among men than women in Canada, with approximately twice as many men compared to women diagnosed with PD (Wong et al., 2014). This study meets expectations in terms of gender proportion for participants as it is consistent with previously reported data of higher number of men with PD.

This study found that 38.2% of participants reported their employment status as full-time or part time. This proportion is higher than the estimated 25-35% of individuals with PD in the workforce according to Parkinson Canada (Parkinson Canada, 2019). It is important to consider that the Parkinson Canada statistic is including individuals at all stages of PD. However, this study may primarily include individuals at a mild or moderate stage of PD, as they are more likely to have a valid driver's license, an inclusion criteria in this study. Individuals at a more advanced stage of PD would be more unlikely to work and have the ability to participate in this online survey, which could reflect the higher proportion of employed participants in this study.

6.1.2 Prior Experience and Preference of ADAS Features

While global market research company Ipsos reported that approximately 12% of Canadians are already equipped with ADAS features in their vehicles as of 2019 (Collision Repair Magazine, 2019), approximately 33% of the participants in this study owned a vehicle that had at least one of the ADAS features that they have been exposed to in a vehicle they had driven. This increased percentage could be reflected due to participants with an interest in ADAS and driving being more likely to participate in the survey. Though income information was not collected in the study, it is important to note the participants in this research may have a certain level of income that would allow them to have prior experience with ADAS given that the vehicles that have them tend to be more expensive.

The top ADAS features participants had most in their vehicles in this study included pedestrian automatic emergency braking followed by forward collision system, lane-centering control and blind spot detector tied in second place. A longitudinal study was done by the AAA Foundation for Traffic safety on the prevalence of using ADAS and change in use over time of ADAS among older adults (Eby et al., 2021). This study looked at prevalence of 15 different ADAS features at baseline and after three years. At the end of the three year period, blind spot warning, forward collision system and lane centering control also ranked highly in the AAA foundation study at fifth, sixth and seventh respectively out of the 15 ADAS features in the study based on percentage of participants having the ADAS feature in their vehicle (Eby et al., 2021). It is important to note that the AAA Foundation explored features that were not in this study such as integrated Bluetooth, navigation assistance and voice control. All these features had ranked in their top 5 features in terms of prevalence. Taking this into consideration, this study showed similar findings of ADAS features being prevalent among older adults as the AAA foundation study.

While pedestrian automatic emergency braking was among the top three most prevalent ADAS features among vehicles in this study, the AAA Foundation study did not explore this feature. However, according to the Insurance Institute for Highway Safety (IIHS), almost 90% of 2021 models of vehicles have pedestrian automatic emergency braking (Barry, 2022). As more companies are including pedestrian automatic emergency braking in their vehicles as time passes, this can explain why this ADAS feature was highly prevalent in vehicles for participants in this study.

The top three ADAS features participants found most useful in this study were lane-centering control, lane-keeping assist and forward collision warning system. These findings are consistent with findings from the AAA Foundation study that asked participants if they believed each of several ADAS features made them a safer driver. If a participant finds an ADAS feature to make them a safer driver, they will likely find it more useful. At the end of the three year longitudinal study, 87.5% of participants found lane-keeping assist to make their driving safer and 84.7% of participants forward collision warning system to make their driving safer which supports this study's findings (Eby et al., 2021).

It is interesting that though lane-keeping assist were chosen as most useful, it was also chosen among the top three least useful features. Similarly, lane-keeping assist and lane-centering control were chosen as the easiest ADAS features to use and also the hardest to use. These results could be explained by numerous factors. A study in Australia found that older adults thought lane-keeping assist could be useful for long trips. However, there were also concerns about the effectiveness of this feature in different weather or road conditions, if the feature would distract them during driving and if it would warn them early enough to take corrective action (Regan et al., 2002). Although this study pertained to the Australian context which has stark differences in weather conditions compared to Canada, this study does provide an insight into the concerns of older adults when it comes to the reliability of these technologies in various environmental settings.

It’s likely that participants who view these features for its benefits, such as being used in long trip for example, would view it more favourable in term of usefulness. In addition, if participants have spent more time using these ADAS features, they might find it easier to use. Alternatively, if the participants are viewing the ADAS features from the perspective of potential risks in their driving and safety, they would find these ADAS features harder to use and less useful as well. It also important to note that while lane-keeping assist was ranked as most useful and least useful, 86 participants found lane-keeping assist most useful, while only 38 participants found lane-keeping assist least useful. Similarly, while both features were ranked as hardest and easiest to use, 88 participants found lane-centering control easiest to use and 85 participants found lane-keeping assist easiest to use, while only 30 participants found lane-centering control hardest to use and 40 participant found lane-keeping assist hardest to use. These findings also offer opportunity for further research to explore user perspectives on theses specific features and areas of improvement.

It is also interesting to note that adaptive cruise control was chosen in the top three least useful and hardest features to use in this study. Potential reasons documented in the literature for this could be that older adults find that adaptive cruise control can lead to reduced situational awareness, delayed braking in critical driving events and being overconfident in the feature (Eby et al., 2016). Older adults may not be clearly understanding situations where this feature can and cannot be used and therefore find it less useful or harder to use in their driving.

6.1.3 Technology Acceptance

This study found that the model was statistically a good fit for intention to use ADAS in the next year and to purchase a vehicle with ADAS features in the future. Previous experience was a significant predictor for intention to use ADAS in the next year which was consistent with findings from the literature. A study found that among drivers who had previous experience with ADAS, 68% of participating older drivers reported liking or very much liking ADAS (Burridge et al., 2020). Previous experience with ADAS can also include training using it. Abraham and colleagues (2017) found that training on using ADAS increased confidence using the system and helped users feel that the benefits of the technology outweighed the drawbacks, which supports findings that experience using ADAS can predict intention to use ADAS in the next year.

Perceived ease of use was a significant predictor for intention to use ADAS in the next year and to purchase a vehicle with ADAS features in the future which is consistent with the literature. Perceived ease of use is defined as “the degree to which a person believes that using a system would be free from effort” (Davis, 1989). Davis also suggested similarity between self-efficacy and perceived ease of use, where if individuals view a technology as easy to use, they would have increased confidence and competence in technology adoption (He et al., 2018). This can be applied to the context of using ADAS features, as it is important for participants to feel confident driving in their vehicles for them to use it on the road and feel safe, which are also important considerations when purchasing a vehicle. Even if one views a technology as useful, they will not use ADAS features if it is too difficult to use, pose perceived risk to their safety or significantly affects their confidence. Ease of use was also documented to be more important for a new user in comparison to an experienced one, which can be applicable for use of ADAS as its emergence is still relatively new in the market and becoming more advanced with time (Regan et al., 2002).

Perceived ease of use is also important to avoid technology abandonment. After initial use for a technology, a user will adapt their usage behaviour to avoid any potential drawbacks of the technology (Li and Luximon, 2018). This can either lead to accepting a technology or abandoning it. This outcome depends on how satisfactory the match is between the user, including their ability to use a technology, and the technology’s specific task requirement (Li and Luximon, 2018). A previous study explored barriers of using mHealth technologies among individuals with PD. An overarching theme that was found was individuals with PD desired independence, self-confidence and autonomy. For example, requiring assistance to use the technology was a barrier that compromised autonomy and independence. Ease of use factors such as design, interactivity and learnability were important considerations. In addition, individuals with PD considered their disease progression for symptom such as tremor to affect their ability to easily use a technology (Grosjean et al., 2020).

The literature has documented higher level of acceptance for ADAS among older adults than young adults as they view ADAS features as a system of convenience that increase feeling comfortable and safe in driving, which is also related to ease of use among this population (Burridge et al., 2020). Older adults can find ADAS features harder to use compared to young drivers based on how advanced the technological interface is. For example, older adults find active voice controls harder to use and display screens harder to read. However, perception on ease of use for features such as adaptive cruise control and lane-keeping assist were viewed as less inconvenient by older adults (Burridge et al., 2020). As such, these finding support that perception of ease of use is a significant predictor among individuals with PD for using ADAS in the next year and for purchasing a vehicle with ADAS features.

Perceived usefulness was a significant predictor for intention to purchase a vehicle with ADAS features in the future, The exploring barriers of using mHealth technologies among individuals with PD found that individuals with PD were more likely to abandon this technology if it didn’t fit in their daily routine or increased social exclusion (Grosjean et al., 2020). This demonstrates that individuals with PD consider if technology is useful for daily life and its benefits.

The literature has found that making vehicle purchasing decisions requires many considerations for older adults. For example, a study explored older driver perceptions of using advanced vehicle technologies and found participants did not make purchases based on age (Gish et al., 2017). They considered its potential to improve safety, space and storage, interest in upgrading vehicle model or being incentivized by a dealer. Though age itself was not a main consideration, participants did consider their physical, sensory, or cognitive impairments that could influence their driving performance (Gish et al., 2017). All these factors could affect perceived ease of use and perceived usefulness of purchasing ADAS features in a vehicle.

Another study exploring vehicle purchase decisions among older adults found that while safety was a consideration for basic standard features such as having a seatbelt or reliable brakes, price was the primary consideration in their purchasing decision (Zhan and Vrkljan, 2011). However, the aim of this thesis did not include the understanding of cost and affordability, though it is likely that it is strongly correlated as a predictor to purchase a vehicle with ADAS features. If an individual cannot afford a technology, they are unlikely to purchase it. Older adults felt that they must carefully consider spending a significant amount of money on a vehicle. They also expressed frustration that many vehicle features come as a package in the car which made the vehicle more expensive, when they only needed some of the features (Zhan and Vrkljan, 2011). Statistics Canada has reported that individuals with PD already have increased personal costs, where 46% of individuals with PD stated spending out-of-pocket expenses not covered by the insurance or the government of $500 or more for medication in the past year. 45% of individuals with PD reported another $500 or more out-of-pocket expenses for additional costs of assistive devices, different types of therapy, home care and other support services (Wong et al., 2014). Taking all these costs into consideration, vehicles with ADAS features may be more prevalent among individuals with higher socioeconomic status due to cost. As such, vehicle purchase decisions are based off consideration of many variables together. Since income and cost was not included for intention to purchase a vehicle with ADAS features in the future, these results are to be interpreted with caution and must be further empirically validated.

6.1.4 Implications

The findings of this study can be beneficial to numerous populations. Healthcare professionals such as neurologists, occupational therapists and nurse practitioners would benefit from these findings as they are all involved in the assessment of physical symptoms and various aspects of driving ability. This is especially important to help overcome the difficult conversations surrounding driving cessation as this technology can be a potentially adequate intervention tool. Our findings suggest that further efforts into researching the effectiveness of ADAS to mitigate the driving errors made by drivers with PD is warranted. This might assist healthcare professionals when assessing driving ability to enable individuals with PD to drive on the road longer and safer than currently possible.

Given the findings of this study, another benefit of ADAS is their role as an equalizer, as most newly manufactured vehicles have ADAS. ADAS constitute a design feature that is meant for all drivers yet has potential to help individuals with PD without stigma. Our findings suggest that individuals with PD have an interest in using ADAS and purchasing these features, which can assist vehicle manufacturers in their further design, commercialization and perhaps involvement in educational efforts. With the increase of the aging population, involving and centering design and commercialization of such features around people diverse levels of driving ability might be helpful to ensure adequate community mobility.

6.2 Limitations and Opportunities

Given the nature of the study (survey) and the timing of data collection (COVID-19 pandemic), this study has certain limitations. First, self-selection bias. Since participants could access the survey online directly and choose whether or not to learn more and visit the link, participants with a particular interest in in-vehicle technologies and driving are more likely to participate. Participants who do not know what ADAS are or participants who do not have access to vehicles with ADAS features may not have chosen to participate. To mitigate the effects of this bias, information about ADAS features was provided at the beginning of the survey. This section included an education check with questions testing their ADAS knowledge to ensure all participants understood what ADAS are and are on the same page. Although this addresses the question of knowledge once a participant chooses to engage with the survey link, the self-selection that brings certain participants to the survey cannot be addressed by this strategy. One option to overcome this limitation in future research is to get permission from a PD related organization, such as Parkinson Canada, and conduct the survey using random sampling to select participants during a support group meeting or by sending the survey through e-mail. However, this option was not available to us given the state of the COVID-19 pandemic.

The questions for current age and age at PD diagnosis were an open field in the demographic section of the survey, which is a limitation as it may have resulted in typos or misinterpretations of the questions. In the future, these age-related questions can use age interval options for the participant responses to avoid any typos and misinterpretations. In addition, income information was not collected in this study which would be interesting for future research to explore factors that impact intention to purchase a vehicle with ADAS features.

Another limitation of this study was that it was conducted online. This implies that only those with internet access would be able to participate in this study and only individuals with a certain level of technology literacy can access the survey. This could have excluded participants who do not know how to use the internet or do not use social media from participating in the survey. A way to overcome this limitation could be to make the survey accessible through other means using a combination of both an online survey and paper survey to reach the greatest number of participants with PD. This would also increase geographic access to this survey for individual in areas such rural and Indigenous reserves. However, given the constraints of the global COVID-19 pandemic, this online survey was preferred to limit any type of contact during the pandemic and takes into consideration that this population group could be especially vulnerable.

Chapter 7

7 Conclusion

Overall, this study has provided insight in understanding the perceptions and attitude of Canadians living with PD towards using ADAS. The majority of participants had a favourable perception in terms of perceived usefulness and perceived ease of use towards ADAS. Most participants also found ADAS slightly, quite or extremely beneficial, good, rewarding and pleasant. Perceived ease of use and previous experience were found to be determinants for intention to use ADAS in the next year. Perceived usefulness and perceived ease of were determinants for intention to purchase a vehicle with ADAS features in the future, though these results are to be interpreted with caution due to the reasoning that vehicle purchase decisions take numerous factors into account. These findings provide valuable insight to optimize technology design and develop client-centered interventions to assist drivers with PD to incorporate these technologies into their driving. Further research can explore a comparative study looking at the effects of expanded education and exposure to ADAS. For example, participants can be exposed to a vehicle with ADAS and given the opportunity to use it under supervision as previous experience was a determinant for intention to use ADAS in the next year. It would also be interesting to explore how much cost may influence a model like the one used in this study for intention to purchase a vehicle with ADAS features. These findings and further research can benefit drivers through added driving confidence, increased number of years to drive across the lifespan and improved community mobility which can all increase quality of life.

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Appendices

Appendix A: HSREB Approval Letter

Date: 1 September 2021

To: Dr. Liliana Alvarez

Project ID: 119317

Study Title: Perception and Attitudes of Canadians living with Parkinson's disease towards using Advanced Driver Assistance Systems (ADAS)

Application Type: HSREB Initial Application

Review Type: Delegated

Full Board Reporting Date: 07/Sept/2021

Date Approval Issued: 01/Sep/2021

REB Approval Expiry Date: 01/Sep/2022

Dear Dr. Liliana Alvarez

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. **All other required institutional approvals and mandated training must also be obtained prior to the conduct of the study**.

Documents Approved:

Document Name	Document Type	Document Date
PAC-ADAS Study Survey_27May2021 (Survey only)	Online Survey	Received August 21, 2021
PAC-ADAS French Study Survey_27May2021 (Survey only)	Translated Documents	Received August 21, 2021
PAC-ADAS Study- Research Protocol Plan_8July2021	Protocol	08/Jul/2021
PAC-ADAS Study - Recruitment Poster_8July2021	Recruitment Materials	08/Jul/2021
PAC-ADAS Study- E-mail Recruitment Script_8July2021	Recruitment Materials	08/Jul/2021
PAC-ADAS Study- French Letter of Information and Consent Form_30August2021	Translated Documents	20/Aug/2021
PAC-ADAS Study- Letter of Information and Consent Form_30August2021	Written Consent/Assent	30/Aug/2021

Documents Acknowledged:

Document Name	Document Type	Document Date
French Attestion of Translation Letter_30August2021	Translation Certificate	19/Aug/2021

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB , except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Karen Gopaul , Ethics Officer on behalf of Dr. Philip Jones, HSREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix B: Online Survey

Title of Study: Perception and Attitudes of Canadians living with Parkinson's disease towards using Advanced Driver Assistance Systems (ADAS)

PI: Liliana Alvarez, PhD

Online Questionnaire

Landing Page

Please select your preferred language.
Veuillez sélectionner votre langue préférée.

1) English
2) Français

---------- Break to next page ----------

Eligibility Criteria Questions

1. Do you have a confirmed diagnosis of Parkinson's disease?
- o Yes
- o No

2. Do you have a valid provincial driver license?
- o Yes
- o No

3. What is your current license status?
- o Full driver's license
- o Learner's permit (e.g., G1 or G2 in Ontario; learner or probationary license in Alberta)

4. Do you reside in Canada?
   - o Yes
   - o No

5. Are you proficient in reading and writing in English?
   - o Yes
   - o No

6. Are you 18 years of age or older?
   - o Yes
   - o No

---------- Break to next page ----------

Not eligible for the survey page

Thank you for your time and interest. However, based on your answers you do not meet the criteria to participate in this survey at this time. None of your responses will be stored.

---------- Break to next page ----------

Eligible for the survey

Thank you, you are eligible to participate in this survey.

Letter of Information

Project Title
Perception and Attitudes of Canadians living with Parkinson's disease towards using Advanced Driver Assistance Systems (ADAS)

Principal Investigator
Dr. Liliana Alvarez
School of Occupational Therapy
Western University

Additional Research Staff and Contact Information

Research Assistant:
Anupradi Sultania
Western University

1. Invitation to Participate

You are being invited to participate in this research study, which aims to explore the perception and attitudes of Canadians living with Parkinson's disease towards using advanced driver assistance systems (ADAS). You have been invited because you are an individual diagnosed with Parkinson's disease who resides in Canada and has a valid provincial driver's license.

2. Why is this study being done?

Parkinson's disease (PD) is the second most common age-related neurogenerative disorder. Individuals with PD can experience numerous challenges in their everyday lives, including driving challenges. ADAS are a form of vehicle automation that assists drivers by automating certain aspects of the driving task such as speed control, collision avoidance, or lane changes. ADAS are primarily designed for routine drivers, but these features have the potential to benefit drivers of all backgrounds, including at risk drivers who are learning to drive, older drivers or medically at-risk drivers. As such, ADAS constitute a potential intervention tool to improve the on-road performance of individuals with PD.

To date, there are limited studies exploring the effectiveness of ADAS among populations with neurological disorders, as this is a relatively new technology and older adults are often excluded from technology design processes within consumer mass markets. However, if the attitude and perception of drivers with PD towards ADAS is adequately understood, there can be increased opportunities for uptake, improved design, access, and use of ADAS in routine driving. This, in turn, may result in increased community participation, reduced vehicle collisions, and a safer driving environment. Thus, this study aims to explore perception and attitudes of Canadians living with Parkinson's disease towards using advanced driver assistance systems (ADAS).

3. How long will you be in this study?

This study consists of an online survey which will take approximately 15 minutes to complete.

4. What are the study procedures?

If you agree to participate, you will be asked to complete an anonymous online questionnaire to share your perceptions and attitudes towards using advanced driver assistance systems (ADAS). The questionnaire will ask about your demographic information, your understanding of ADAS, prior experiences with ADAS, followed by perceived usefulness, perceived ease of use, attitude and behavioural intention to use ADAS.

5. What are the risks and harms of participating in this study?

Participants in this study are at a low risk to experience harm resulting from this study. All responses will remain anonymous, and you can choose to skip any question at any point.

6. What are the benefits of participating in this study?

This study will not result in any direct benefits to you. You will provide your insights to help explore explore the perception and attitudes of Canadians living with Parkinson's disease towards using advanced driver assistance systems (ADAS). Possible benefits to society include ADAS design input for designers and manufacturers, programs that can better educate drivers with PD about ADAS, purchase and use.

7. Can participants choose to leave the study?

Your participation in this study is voluntary. You are free to refuse to participate, or to withdraw from the study at any time without giving a reason and without negative consequences. If you choose to withdraw from this study during survey completion, your responses will not be stored. After you submit your survey responses, however, the anonymous information that was collected prior to you leaving the study will still be used as we will not be able to remove anonymous answers. No new information will be collected without your permission.

8. How will participants' information be kept confidential?

The survey is completely anonymous. In addition, all responses will remain accessible only to the investigators of this study. Unidentifiable data resulting from the survey responses may be shared for purposes of secondary data analysis or during the dissemination of this research (e.g., journal publication). Electronic data will be stored in a password protected computer and server network according to the privacy and confidentiality policies of Western University. Representatives of Western University's Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research.

9. Are participants compensated to be in this study?

As a token of appreciation for your time, you can be entered into a draw (by providing your email address) to win one (1) of eight (8) gift cards for Amazon.ca that are worth $25 each. An email address is only collected as a method to indicate the winner of the draw and will be kept separate from the data, thus your email address will not be linked to your survey responses nor will it make identification possible. The chances of winning depend on the number of individuals who respond to the survey.

10. What are the rights of participants?

Your participation in this study is voluntary. You may decide not to be in this study. Even if you consent to participate you have the right to not answer individual questions or to withdraw from the study at any time. If you choose not to participate or to leave the study at any time, this will have no negative consequence to you. You do not waive any legal right by consenting to this study.

11. Whom do participants contact for questions?

If you have questions about this research study, please contact:

Dr. Liliana Alvarez
School of Occupational Therapy
Western University

If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Human Research Ethics.

Consent Form

Project Title: Perception and Attitudes of Canadians living with Parkinson's disease towards using Advanced Driver Assistance Systems (ADAS)

Study Investigator's Name: Liliana Alvarez, PhD, School of Occupational Therapy, Western University

Having read the information above, I understand that by clicking "I agree to participate" below, I declare that I have received and read the Letter of Information, have had the nature of the study explained to me and I agree to participate.

"Yes, I agree to participate."

"No, I do not agree to participate."

---------- Break to next page ----------

“I do not agree to participate” follow-up page

Thank you for your time. You have decided not to participate in this study. No data has been collected from you.

---------- Break to next page ----------

“I agree to participate” page:

Thank you for agreeing to participate in this study. When you are ready, you can start the questionnaire. If you wish to quit the questionnaire at any time, please close the page and no responses will be recorded.

Your participation is greatly appreciated, and it will allow us to gain a better understanding of the perception and attitudes of Canadians living with Parkinson’s disease towards using advanced driver assistance systems (ADAS). Remember that the questionnaire is anonymous, so try to answer as honestly as possible.

Demographic Questions

1. With which gender identity do you most closely identify?

- Male
- Female
- You do not have an option that applies to me. I identify as __________
- I prefer not to answer

2. What is your current **age**?

- Age: (Insert)

3. At what age were you diagnosed with Parkinson’s disease?

- Age: (Insert)

4. Which of the following do you feel best describes your ethnicity? Select all that apply.

Note: The following answer options have been taken from the 2021 Statistics Canada long-form census questionnaire.

- White
- South Asian (e.g., East Indian, Pakistani, Sri Lankan)
- Chinese
- Black
- Filipino
- Arab
- Latin American
- Southeast Asian (e.g., Vietnamese, Cambodian, Laotian, Thai)
- West Asian (e.g., Iranian, Afghan)
- Korean
- Japanese
- Other group — specify:

5. What is the highest certificate, diploma and/or degree that you have completed?

- Less than a high school diploma
- High school degree or equivalent
- College, CEGEP or other non-university certificate or diploma
- Bachelor’s Degree
- Master’s Degree
- Doctorate degree

6. What is your employment status?

- Employed Full-Time
- Employed Part-Time
- Unemployed – seeking work opportunities
- Unemployed – not looking for work
- Retired
- Student
- Unable to work

7. What is your province/territory of residence?

- Newfoundland and Labrador
- Prince Edward Island
- Nova Scotia
- New Brunswick
- Quebec

- Ontario
- Manitoba
- Saskatchewan
- Alberta
- British Columbia
- Yukon
- Northwest Territories
- Nunavut

---------- Break to next page ----------

Current Knowledge of ADAS

It is expected that each person will have varied knowledge of advanced driver assistance systems (ADAS). Based on your current knowledge of ADAS features, please answer the following questions.

1. How would you rate your current knowledge of ADAS?
   - Poor
   - Fair
   - Good
   - Excellent

2. Which of the following technologies is an example of ADAS?
   - Car feature that maintains the vehicle in the center of the lane
   - Car feature that warms up the seat in a vehicle
   - Car feature that activates windshield wipers

3. Which of the following technologies is NOT an example of ADAS?
   - Car feature that maintains speed and distance from the lead vehicle
   - Car feature that warns if a vehicle is in the blind spot
   - Car feature that plays songs via Bluetooth from a phone

---------- Break to next page ----------

What is ADAS?

Many vehicles nowadays have technology that assists with controlling certain aspects of the driving task such as helping the driver control the speed or change lanes. These technologies use sensors and cameras to assist the driver with driving tasks ranging from assisting the driver with one specific function (e.g., maintaining the vehicle in the centre of the lane) to technologies with combined functions (e.g., automatically steering and moving the vehicle into a parking spot).

These technologies are collectively called advanced driver assistance systems or ADAS for short.

It is estimated that approximately 12% of Canadian drivers today have vehicles that have one or more of these features. Some of the most common ADAS features currently available in vehicles include technologies that:

- Correct the vehicle position if drifting towards the incoming lane (Lane-Keeping Assist)
- Maintain the vehicle in the center of the lane (Lane-Centering Control)
- Warn the driver and automatically apply the brakes if a pedestrian is detected (Pedestrian Automatic Emergency Braking)
- Automatically apply the brakes if vehicle is at risk of a potential collision (Forward Collision Warning System)
- Monitor intersection traffic and automatically apply brakes in hazardous situations (Intersection Assistant)
- Warn if a vehicle is in the blind spot (Blind Spot Detection)
- Increase road visibility in darkness/night beyond the reach of vehicle's headlights (Automotive Night Vision)

For more information, visit https://www.nhtsa.gov/equipment/safety-technologies to learn more details about these technologies.

Based on this information and your knowledge of ADAS features, please answer the following questions.

1. Which of the following technologies is an example of ADAS?
   - Car feature that plays songs via Bluetooth from a phone
   - Car feature that activates windshield wipers
   - Car feature that maintains speed and distance from the lead vehicle

2. Which of the following technologies is NOT an example of ADAS?
   - Car feature that warms up the seat in a vehicle
   - Car feature that maintains speed and distance from the lead vehicle
   - Car feature that automatically steers and moves the vehicle into parking spot

3. Which of the following technologies is an example of ADAS?

(A) Car feature that maintains the vehicle in the center of the lane
(B) Car feature that maintains speed and distance from the lead vehicle
(C) Car feature that automatically steers and moves the vehicle into parking spot

- None of the above
- Only option B
- All of the above

4. After being given information on ADAS above, how would you rate your overall knowledge of ADAS?
   - Poor
   - Fair
   - Good
   - Excellent

---------- Break to next page ----------

Prior Experience with ADAS

1. Which of the following best describes your experience with ADAS?

   Note: Experience using ADAS can include any previous experience driving a vehicle with ADAS features such as renting a vehicle with any single or multiple ADAS features, test driving a vehicle with ADAS features, borrowing a vehicle with ADAS features from someone you know, owning a vehicle with ADAS that you drive etc.

A. I have driven a vehicle with ADAS features

B. I have been a passenger in a vehicle with ADAS features

C. I have not been a driver or a passenger of a vehicle with ADAS features

---If A is chosen from question 1, questionnaire displays question 2----

2. To which of the following ADAS features have you been exposed to in a vehicle you have driven? Select all that apply.

- Car feature that automatically steers and moves the vehicle into parking spot
- Car feature that corrects the vehicle position if drifting towards the incoming lane
- Car feature that maintains the vehicle in the center of the lane
- Car feature that maintains speed and distance from the lead vehicle
- Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected

- Car feature that automatically apply the brakes if vehicle is at risk of a potential collision
- Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
- Car feature that warns if a vehicle is in the blind spot
- Car feature that increases road visibility in darkness/night beyond the reach of vehicle's headlights
  Other: ____________
- None of the above

3. Do you own a vehicle that has any of the ADAS features listed in Question 2?

- Yes
- No

---If yes is chosen----

4. If you own a vehicle with ADAS feature, which of the following ADAS features does your vehicle have? Select all that apply.

- Car feature that automatically steers and moves the vehicle into parking spot
- Car feature that corrects the vehicle position if drifting towards the incoming lane
- Car feature that maintains the vehicle in the center of the lane
- Car feature that maintains speed and distance from the lead vehicle
- Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected
- Car feature that automatically apply the brakes if vehicle is at risk of a potential collision
- Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
- Car feature that warns if a vehicle is in the blind spot
- Car feature that increases road visibility in darkness/night beyond the reach of vehicle's headlights
  Other: ____________
- None of the above

5. How often do you drive a vehicle with ADAS features?
    - Daily
    - Weekly
    - Monthly
    - Yearly
    - Rarely (used ADAS one or two times in total)
    - Never

---If B is chosen from question 1, questionnaire displays question 6----

6. Which of the following ADAS features have you been exposed to in a vehicle you have been a passenger in? Select all that apply.
   - Car feature that automatically steers and moves the vehicle into parking spot
   - Car feature that corrects the vehicle position if drifting towards the incoming lane
   - Car feature that maintains the vehicle in the center of the lane
   - Car feature that maintains speed and distance from the lead vehicle
   - Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected
   - Car feature that automatically apply the brakes if vehicle is at risk of a potential collision
   - Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
   - Car feature that warns if a vehicle is in the blind spot
   - Car feature that increases road visibility in darkness/night beyond the reach of vehicle's headlights
   - Other: ____________
   - None of the above

7. How often have you been a passenger in a vehicle with ADAS features?
   - Daily
   - Weekly
   - Monthly
   - Yearly
   - Rarely (used ADAS one or two times in total)
   - Never

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ADAS Technology Acceptance Questions

In your daily experiences, there might be some features of ADAS that you prefer over others. In contrast, there may be some specific ADAS that you do not like using. There will be questions at the end of the section that will allow you to specify if you have any preferences. For the following questions, please answer with the thought of ADAS in general.

Perceived Usefulness

1. Using ADAS in my driving would enable me to accomplish tasks more quickly.

likely	______	______	______	______	______	______	______	unlikely
	extremely	quite	slightly	neither	slightly	quite	extremely	

2. Using ADAS would improve my driving performance.

likely	______	______	______	______	______	______	______	unlikely
	extremely	quite	slightly	neither	slightly	quite	extremely	

3. Using ADAS would enhance my effectiveness on driving.

likely	______	______	______	______	______	______	______	unlikely
	extremely	quite	slightly	neither	slightly	quite	extremely	

4. Using ADAS would make it easier to do my driving.

likely	______	______	______	______	______	______	______	unlikely
	extremely	quite	slightly	neither	slightly	quite	extremely	

5. I would find ADAS useful in my driving.

likely	______	______	______	______	______	______	______	unlikely
	extremely	quite	slightly	neither	slightly	quite	extremely	

Which of the following ADAS are or would be most useful to you? (Select all that apply.)

- Car feature that automatically steers and moves the vehicle into parking spot
- Car feature that corrects the vehicle position if drifting towards the incoming lane
- Car feature that maintains the vehicle in the center of the lane
- Car feature that maintains speed and distance from the lead vehicle
- Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected
- Car feature that automatically apply the brakes if vehicle is at risk of a potential collision
- Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
- Car feature that warns if a vehicle is in the blind spot
- Car feature that increases road visibility in darkness/night beyond the reach of vehicle’s headlights
- Other: ____________

Which of the following ADAS are or would be the least useful to you? (Select all that apply.)

- Car feature that automatically steers and moves the vehicle into parking spot
- Car feature that corrects the vehicle position if drifting towards the incoming lane
- Car feature that maintains the vehicle in the center of the lane
- Car feature that maintains speed and distance from the lead vehicle

- Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected
- Car feature that automatically apply the brakes if vehicle is at risk of a potential collision
- Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
- Car feature that warns if a vehicle is in the blind spot
- Car feature that increases road visibility in darkness/night beyond the reach of vehicle's headlights
- Other: ____________

Perceived Ease of Use

1. Learning to operate ADAS would be easy for me.

likely |______|______|______|______|______|______|______| unlikely
extremely quite slightly neither slightly quite extremely

2. I would find it easy to get ADAS to do what I want it to do.

likely |______|______|______|______|______|______|______| unlikely
extremely quite slightly neither slightly quite extremely

3. My interaction with ADAS would be clear and understandable.

likely |______|______|______|______|______|______|______| unlikely
extremely quite slightly neither slightly quite extremely

4. I would find ADAS to be flexible to interact with.

likely |______|______|______|______|______|______|______| unlikely
extremely quite slightly neither slightly quite extremely

5. It would be easy for me to become skillful at using ADAS.

likely |______|______|______|______|______|______|______| unlikely
extremely quite slightly neither slightly quite extremely

6. I would find ADAS easy to use.

likely |______|______|______|______|______|______|______| unlikely
extremely quite slightly neither slightly quite extremely

Which of the following ADAS are or would be easiest to use for you? (Select all that apply.)

- Car feature that automatically steers and moves the vehicle into parking spot
- Car feature that corrects the vehicle position if drifting towards the incoming lane
- Car feature that maintains the vehicle in the center of the lane
- Car feature that maintains speed and distance from the lead vehicle
- Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected
- Car feature that automatically apply the brakes if vehicle is at risk of a potential collision

- Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
- Car feature that warns if a vehicle is in the blind spot
- Car feature that increases road visibility in darkness/night beyond the reach of vehicle's headlights
- Other: ____________

Which of the following ADAS are or would be hardest to use for you? (Select all that apply.)

- Car feature that automatically steers and moves the vehicle into parking spot
- Car feature that corrects the vehicle position if drifting towards the incoming lane
- Car feature that maintains the vehicle in the center of the lane
- Car feature that maintains speed and distance from the lead vehicle
- Car feature that warns the driver and automatically apply the brakes if a pedestrian is detected
- Car feature that automatically apply the brakes if vehicle is at risk of a potential collision
- Car feature that monitors intersection traffic and automatically apply brakes in hazardous situations
- Car feature that warns if a vehicle is in the blind spot
- Car feature that increases road visibility in darkness/night beyond the reach of vehicle's headlights
- Other: ____________

Attitude

Using ADAS in my driving would be

harmful _______:_______:_______:_______:_______:_______:_______ beneficial
extremely quite slightly neither slightly quite extremely

Using ADAS in my driving would be

good _______:_______:_______:_______:_______:_______:_______ bad
extremely quite slightly neither slightly quite extremely

Using ADAS in my driving would be

rewarding _______:_______:_______:_______:_______:_______:_______ punishing
extremely quite slightly neither slightly quite extremely

Using ADAS in my driving would be

unpleasant _______:_______:_______:_______:_______:_______:_______ pleasant
extremely quite slightly neither slightly quite extremely

Intention to Use

I intend to use ADAS in the next year.

likely |_______|_______|_______|_______|_______|_______|_______| unlikely
extremely quite slightly neither slightly quite extremely

If I purchase a vehicle in the future, I intend to purchase a vehicle with ADAS features in it.

likely |_______|_______|_______|_______|_______|_______|_______| unlikely
extremely quite slightly neither slightly quite extremely

This ends the questionnaire. Thank you for participating!

To submit the survey, please click “Submit Survey”.

If you want to produce any commentary, write in the space below:

(Add comment box)

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Amazon.ca Giftcard Draw

Thank you again for your assistance! As a token of appreciation for your time, we are conducting a draw of 8 individual $25 gift cards for Amazon.ca. If you would like to be entered into the draw, please enter your email below. You do not have to enter the draw; it is completely optional.

An email address is only collected as a method to indicate the winner of the draw and will be kept separate from the data, thus your email address will not be linked to your survey responses nor will it make identification possible.

By providing your email, you are providing consent to being contacted in the event that you win.

Email (optional): ___________

Please click the “Submit” button to be entered in the draw.