RURAL OLDER ADULT DRIVER TAILORED RESEARCH-INTEGRATED PLAN (ROAD TRIP)

FINAL REPORT

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16. Abstract

The objective of this work was to draw upon prior research to support rural older drivers by identifying unmet needs and current limitations, then providing customized mobility plans. A customized algorithm was devised to provide a series of probes and discussion points, along with predetermined interventions, to explore at a consultation meeting with the participant. Phase 1 used naturalistic driving data along with other assessments, while Phase 2 uses a standardized test route and a cellphone-based app to perform driving assessments. When considering those that either marked strongly agree or somewhat agree to key exit interview questions, the following findings become apparent:

- 89% felt well-being increased as a result of the program
- 100% felt the program was worthwhile
- 100% would like to continue with the program
- 89% would recommend the program to others

The ROAD TRIP program revealed an opportunity for improvement in working with older adult drivers. The progression from Phase 1 to Phase 2 highlighted the need for streamlined processes to expand to a larger audience. Regardless of the driving data methodology employed, participants spoke highly of the program, which highlights both the need for continued use and for further expansion, potentially with the aid of other organizations.

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EXECUTIVE SUMMARY

Introduction

Projections for the United States clearly show the population is aging. By 2030 all members of the Baby Boom generation will be older than 65, while 20% of the country's residents will be of retirement age (Colby & Ortman, 2015). This trend indicates the need to help those aging drivers continue to maintain independence and mobility.

Several driving scenarios are challenging or reveal higher crash rates for older drivers, such as driving at night (Gruber et al., 2013; Myers et al., 2011), in inclement weather (Gruber et al., 2013; Myers et al., 2011), at high speeds (Bergen et al., 2017), through intersections and roundabouts (Braitman et al., 2007; Caird et al., 2005; Sun et al., 2018; Sun et al., 2019; Wood et al., 2013), and changing lanes or merging (Antin et al., 2020; Wood et al., 2013). Despite these increased challenges, many older drivers may be forced to drive out of necessity, even if their driving abilities have already begun to decline (Johnson, 2002). While no two individuals will age the same, the presence of physical and cognitive declines will likely affect everyone in some capacity.

The objective of this work is to draw upon prior research to provide support for the rural older driver by identifying unmet needs and current limitations. This information was then utilized to provide a customized consultation plan.

Methods

Data gathered from surveys, psychomotor assessments, and a variety of driving-related sources was processed through a customized algorithm. The algorithm provided a series of probes and discussion points, along with predetermined interventions, to explore at a consultation meeting with the participant. The consultation was completed with a minimum of two researchers present and occurred either at the participant's home or the research facility. These sessions were typically completed in 2 hours. The driving data component of this effort was explored between several modalities. Phase 1 used naturalistic driving data (video views and kinematic data) in conjunction with the data collection, while Phase 2 explored the use of a standardized test route or the use of a cellphone-based app.

Results

Findings from the naturalistic assessment were mixed but encouraging. Due to the low number of participants who were involved in both the naturalistic data collection *and* the following interventions, caution should be observed. Discussions that attempted to decrease participants' engagement in secondary tasks resulted in a minor observed reduction of 0.3 tasks per segment analyzed. However, backup camera discussions resulted in an average increase of their use in backing situations from 40.0% to 51.4%. Discussions related to drowsiness did not produce any meaningful change in observed behavior. Finally, discussions related to completing a full stop at stop signs did prove beneficial for both participants who received that intervention, showing an average increase in full-stops from 25% to 44.2%.

The CarFit session was nearly universally praised. Nine participants stated that the side mirror adjustments improved their visibility, but it is worth noting that in one case the participant felt a decrease in confidence until she became accustomed to the different positioning. Seating position and steering wheel adjustments were also well received, with five participants saying they now felt safer. One participant noted the adjustments to the seating position had a particularly large impact on her:

she no longer has foot cramps from stretching to reach the pedals and no longer has shoulder pain from the steering wheel position.

Results from the exit survey highlighted several important findings. A total of 84% of participants indicated they *strongly agreed* that they could get to required locations after the consultation session compared to 58% pre-consultation. Similarly, 63% indicated they *strongly agreed* to driving with confidence after the consultation when driving compared to 50% pre-consultation. The ability to access needed locations in unplanned situations also showed improvement, with 100% of participants saying these needs are usually met compared to 84% pre-consultation.

When considering those that either marked *strongly agree* or *somewhat agree* to key exit interview questions, the following findings become apparent:

- 89% felt well-being increased as a result of the program
- 100% felt the program was worthwhile
- 100% would like to continue with the program if available
- 89% would recommend the program to others
- 87% felt the consultation made them feel safer or more confident about their driving

Finally, exit survey responses of *strongly agree* or *somewhat agree* indicated that the hands-on (93%) and tailored aspects (93%) of the program were important to the program's success.

Discussion

Nearly every participant provided the researchers with numerous unsolicited compliments and praise for the study. These are important because they suggest the program is providing a service where it is needed. The anecdotal findings also mirrored the results from the exit survey presented above. Improvements in several facets were noted, along with participants indicating a desire to not only continue with the program but recommend it to others. Taken together, these findings indicate a high level of acceptance. Older drivers recognize the need for a program such as this one, feel that they receive a benefit from participating, and indicate a desire to continue with the program if available. Future iterations should leverage the work detailed in this effort and work to reach a wider audience.

The degree of driving impairment may be related to the perceived benefit. Participants who felt the provided suggestions were not currently applicable could be related to those with a higher level of independence or those who experience fewer transportation barriers. Those who spoke more highly of the suggestions for their current application may be those who feel their independence is starting to wane or are those with a greater number of transportation barriers. Ideal candidates would likely include a variety of factors such as significant mobility concerns (but still functionally mobile enough to benefit from the process), openness, social support, and environmental conduciveness among others.

Conclusion

The ROAD TRIP program revealed an opportunity for improvement in working with older adult drivers. The program was nearly universally praised by participants and resulted in observable behavior change on a per-participant basis. The progression from Phase 1 to Phase 2 highlighted the need for streamlined processes to better expand to a large footprint. The initial program relied on highly technical data collection equipment that provided a wealth of rich, detailed information but was expensive and time-consuming to utilize. Phase 2 expanded the conceptual footprint by replacing the naturalistic data collection with a standardized test route, which reduced overhead but was mostly

beneficial only for pre-consultation data. Further expansion was achieved with the use of a smartphone-based data collection app, which was both highly deployable and required little researcher overhead. Regardless of the driving data methodology employed, participants spoke highly of the program, which highlights both the need for continued use and for further expansion, potentially with the aid of other organizations such as AARP or car insurance organizations.

DESCRIPTION OF PROBLEM

INTRODUCTION

An Aging Society

Globally, we are an aging population, and projections for the United States mirror that trend. By 2030, all members of the Baby Boom generation will be over the age of 65, and 20% of the residents in the United States will be retirement age (Colby & Ortman, 2015). By 2034, the population of those over 65 is projected to eclipse that of those under the age of 18 for the first time in U.S. history (U.S. Census Bureau, 2018). Additionally, the population of those over the age of 85, sometimes referred to as the *oldest old*, is projected to increase 118% from 6.1 million in 2019 to 14.4 million by 2040 (U.S. Census Bureau, 2018). Those aged 65 and older are rapidly becoming the focus of research, marketing, and government initiatives (Henderson et al., 2017). Many industries and societal institutions such as healthcare (Morley, 2020), housing (Thomas & Applebaum, 2015), and financial planning (Greninger et al., 2000) may not yet be fully prepared for this demographic trend. The transportation industry is no different and is already feeling the impacts of a rapidly aging society (Coughlin, 2009; Loukaitou-Sideris et al., 2018; Rahman et al., 2020).

Impacts of Aging on Driver Competencies

Data on crash-related fatalities indicate that, on average, 19 older adults die each day in vehicle crashes and another 712 are injured (Greene & Smith, 2019). Many older adults may continue to drive out of necessity, even in the presence of diminished abilities (Johnson, 2002). While no two individuals will experience aging in the exact same manner, physical and cognitive declines are likely to affect all to some degree. Unfortunately, the likelihood of developing any number of health conditions increases with age and may make driving less safe or less desirable. Twenty percent of those aged 65–74, 30% of those aged 75–84, and 50% of those 85 and older have health-related difficulties (Mattson, 2012). Cognitive declines associated with aging, which may negatively and specifically impact driver competency, include changes in perceptual ability, such as the ability to judge distances correctly, and information processing speed, which is needed to react quickly to emergent driving scenarios that sometimes require the tracking of multiple threats (Dawson et al., 2010).

Researchers have sought to determine the link between driving deficits and cognitive or physical decline. Dawson et al., (2010) identified the neuropsychological factors associated with driving impairment in older adults and concluded that maneuvers requiring visuospatial abilities (e.g., navigating a turn or changing lanes) and visuomotor abilities (e.g., braking reaction times) are associated with increases in driving risk (Wagner et al., 2011). In addition, the executive functioning required to safely navigate an intersection may exceed the capabilities of some as it requires performing multiple tasks simultaneously, including decisions on lane choice, vehicle alignment, vehicle positioning relative to other drivers, and control of speed and steering angle (Thompson et al., 2012; Ward et al., 2018; Wechsler et al., 2018). Prior research has shown that older adults may take twice as long as younger adults to process information that involves cognitive, perceptual, and motor components, and this processing delay can prove fatal (Braitman et al., 2007; Tam et al., 2015).

Driving Challenges Faced by Older Adults

Several driving maneuvers have proven challenging, revealing higher crash rates for older adults. These include driving at night (Gruber et al., 2013; Myers et al., 2011), in inclement weather (Gruber et al., 2013; Myers et al., 2011), at high speeds (Bergen et al., 2017), through intersections and roundabouts (Braitman et al., 2007; Caird et al., 2005; Sun et al., 2018; Sun et al., 2019; Wood et al., 2013), and while changing lanes or merging (Antin et al., 2020; Wood et al., 2013). In many cases, older drivers self-regulate their driving, avoiding or minimizing exposure to scenarios perceived as being more difficult to manage or higher risk. Conversely, even though a high percentage of older drivers (80%) acknowledged feeling more protected when they avoided driving in certain situations, 75% of that sample also reported *rarely or never* avoiding those areas (Stalvey and Owsley, 2000). This finding suggests that older drivers are open to behavioral interventions to improve safety; however, many may not have sufficient meta-awareness to recognize the degree of sensory or perceptual deficits they are experiencing (Wood et al., 2013). Also, even those who are aware of their limitations may choose to continue to drive out of perceived necessity, especially those in rural areas with fewer options (Ng et al., 2020; Strogatz et al., 2020).

Impacts on Rural Older Adults

Older adults comprise a larger percentage of rural residents (17.5%) compared to urban environments (13.8%; Smith & Trevelyan, 2019). As noted above, rural localities often afford fewer transportation options (Myers, Ipsen, and Stanley, 2022; Perez et al., 2021; Skoufalos et al., 2017). Additionally, their typically longer travel distances, often require additional planning (Perez et al., 2021). Nearly 93% of male and 82% of female rural residents aged 65 and older continue to drive (Brown et al., 2020). Additionally, 63% of men and 40% of women over the age of 85 still drive, which may be indicative of continued higher risk driving, potentially in the presence of age-related deficits (Brown et al., 2020). While public transportation can play a major role in affording mobility, it faces practical issues related to the cost and efficiency of running a service in sparsely populated areas. Without a robust set of alternative transportation options, rural older adults may see negative impacts on health as access to quality care may be reduced. More than 17 million people live in rural counties without a health clinic and 15 million without a federally qualified health center (Clawar et al., 2018). The total number of rural hospitals is declining; 135 have closed since 2010 (6.5% of a total of 2083), with 19 additional closures in 2020 (Kozhimannil & Henning-Smith, 2021). Furthermore, hospital shutdowns have increased nearly every year since 2010, with 453 additional rural hospitals vulnerable due to financial constraints (Kaufman et al., 2016; Kozhimannil & Henning-Smith, 2021). Fewer rural hospitals create longer drive times for essential and emergency services (Brown et al., 2020; McCarthy et al., 2021). Older adults who choose to age in place in rural communities may have a significant reduction in quality of life if they are unable to access needed physical and mental health services, groceries, and meaningful social interactions.

Mobility Matters for Older Adults

The effects of aging on physical and cognitive decline are widely researched and impact many facets of an older adult's life, including mobility (Brelet et al., 2016; Dawson et al., 2010; Howcroft et al., 2019; Ng et al., 2020; Zook et al., 2009). However, transportation resources may slow age-related mobility declines by improving access to medical treatment and preventative care (Hansen et al., 2020), and improving opportunities for physical activity and wellness (Amagasa et al., 2018), lifelong

learning (Merriam & Kee, 2014), volunteering (Konrath et al., 2012), and maintaining contact with family and friends (Taylor et al., 2018). Transportation is also necessary for rural older adults who may struggle to find healthy, affordable groceries, which may result in a reliance on fast food or convenience stores to meet nutritional needs. Thus, rural communities are often classified as *food deserts* due to the residents' relative inability to access fresh fruits and vegetables, which are crucial for older adults who are especially vulnerable to the effects of malnutrition (Bardenhagen et al., 2017; Byker Shanks et al., 2017).

Staying mobile reduces isolation and allows for more social engagement, which can decrease feelings of loneliness and increase interpersonal connection with family, friends, and community (Hansen et al., 2020; Taylor et al., 2018). Mobility can aid older adults in retaining their independence and autonomy, which can reduce feelings of burdensomeness on friends and family. Although many older adults experienced social isolation and loneliness before the pandemic, COVID-19 further illuminated the negative ramifications of social isolation in older adulthood (Blazer, 2020; Smith et al., 2020; Qin et al., 2020). Additionally, two primary risk factors for older adult suicide are feelings of hindered belongingness and perceived burdensomeness, with a particularly high risk resulting from the combination of both factors (Van Orden et al., 2010). Addressing such feelings is crucial as older adults have the highest rate of completed suicides (Conejero et al., 2018; Stanley et al., 2016). Unfortunately, many older adults may have risk factors for suicide, but these are potentially more prominent for non-drivers in rural areas in part due to their geographic isolation (Arbore, 2019; Chu et al., 2017).

Efforts to Increase Mobility

Several concerted efforts exist to improve the mobility of older adults. Some key examples include *FlexDanmark & Flextrafik, iTN America,* and local efforts such as *Drive A Senior* located in Austin, Texas. FlexDanmark, a Scandinavian software company, provides technical support to Flextrafik, a demand-driven transportation network serving older adults, people with disabilities, and rural residents. Flextrafik connects and leverages over 550 transport providers using an algorithm that dispatches vehicles when and where needed across disparate companies, government agencies, jurisdictions, and platforms. Although this is a highly efficient use of resources, it requires population-dense areas to be fully realized.

The Independent Transportation Network (iTN), a non-profit, leverages volunteer drivers and a credit system to connect older adults and those with vision impairments with safe and dependable transportation services. Since its inception in 1988, iTN America has provided over one million rides and currently has over 400 active volunteers. While working to increase mobility for this population, the current service area is somewhat limited as the network only includes 11 communities in 10 states, and volunteers may prove even more difficult to access in low-density rural areas. In 2021, iTN*Country* was launched by the same non-profit in 10 communities ("Transportation for rural", n.d.). By leveraging components already developed and utilized by iTN America, iTN*Country* plans to partner with local stakeholders to bring service to those in more rural areas. In addition to repurposing national-level components, iTN*Country* provides an educational software solution designed to provide local community transportation providers with the knowledge to succeed.

Local organizations such as Drive A Senior in Austin, Texas, can provide friendly, personalized services, but are often constrained by funding, which hinders their ability to serve a wider area. Drive

A Senior attempts to circumvent this limitation by partnering with other local non-profit organizations located throughout the greater Austin area. Unfortunately, even though the partnerships create good coverage for the Austin metro area by the Drive A Senior network, anyone living outside of the predesignated areas is left unserved.

While public transportation can play a major role in providing much-needed transportation to older adults, providing service to individuals in low population densities is a less-than-optimal business plan. Some transportation stakeholders have explored methods to further their reach. Strategies typically include the use of flexible services or partnerships with nearby organizations (Bond, Brown, and Wood, 2017). Flexible services can include options such as paratransit, demand-response services, deviated routes, and volunteer driver programs. Individual stakeholders have noted positive results of these efforts; however, large-scale objective evidence is lacking (Bond, Brown, and Wood, 2017). Autonomous shuttles may have great potential for serving the transportation needs of older adults. However, to date these have not yet proven feasible, particularly for those in rural areas. Much of the roadway infrastructure in rural areas includes faded or non-existent lane lines and broken surfaces, not the quality required for use by current autonomous vehicle technologies. Further, older adults have expressed safety concerns with autonomous vehicles, particularly in the absence of an attendant (Perez et al., 2021). Additionally, older adults with fixed incomes might find the costs of autonomous shuttles prohibitive unless government subsidies provide reduced fares. Unfortunately, those living in rural areas without high levels of connectivity may not take advantage of, or even have access to, current solutions.

Although efforts to increase the mobility of older adults mentioned above may work in some urban locales, the majority of those in rural areas would not be served by such services. A more inclusive approach would improve the mobility of older adults in *all* locations including urban, suburban, and rural areas.

Training

Training has been shown to be an effective intervention in helping to improve driving safety (Anstey et al., 2018; Ashman, Bishu, Foster, and McCoy, 1994; Owsley et al., 2004). Older adult drivers who received tailored lessons to improve driving skills and habits have shown a reduction in hazardous driver behaviors or errors and increased scores on a driver safety rating assessment (Anstey et al., 2018). Similarly, tailored training for drivers showed positive effects on driver performance (Ashman, Bishu, Foster, and McCoy, 1994) or an increase in self-imposed restriction (Owsley et al., 2004). Finally, a systematic review of training programs for older drivers showed that tailored training can be useful in improving safety knowledge, perception related to driving abilities, and driving performance (Sangrar et al., 2019). Together, these findings suggest the use of personalized or tailored training as an effective tool for improving older driver safety.

Objective

The objective of the current effort was to develop a program to support the rural older adult by identifying unmet needs and current limitations, then providing an individually tailored solution, integrating a variety of tools and techniques to meet those needs and mitigate driving risks. Such a program would provide a unique and personalized service to these individuals with the goal of increased quality of life through improved mobility and increased safety.

This effort was conducted in two main phases. Phase 1 was developed to meet the objectives outlined above. Phase 2 was created to devise an approach that would be able to more broadly extend and apply the program established in Phase 1.

APPROACH AND METHODOLOGY

Participants

The demographics for Phase 1 participants are shown in Table 1.

Table 1. Participant and Vehicle Demographics

Sex	N. Participants	Age Range (mean)	Vehicle Year Range
Male	5	67-80 (72.6)	2007-2022
Female	5	67-84 (73.0)	2010-2019

Procedure

All study protocols were approved by Virginia Tech's Institutional Review Board (IRB, # 21-468) prior to participant recruitment or implementation. After a potential participant was identified using the Virginia Tech Transportation Institute (VTTI) participant database, that individual was contacted and, if interested, screened.

Inclusion Criteria

Eligibility requirements included:

1. Aged 60 or older;
2. Judged to be living in a rural, semi-rural, or otherwise remote area within approximately 1 hour of VTTI;
3. Reported transportation or mobility-related difficulties.

Additionally, an effort was made to seek an ethnically diverse population for a more representative sample. Once interest was expressed and eligibility established, a copy of the informed consent document (Appendix A) and a self-addressed and stamped envelope with a copy of the Self-Administered Gerocognitive Exam (SAGE, Scharre, 2007) were sent to the prospective participant. The SAGE was selected as the cognitive fitness screening tool due to a variety of factors, including its short completion time (5 to 10 minutes), the variety of cognitive facets assessed, the fact that it is a self-administered instrument, and a scoring rubric that ensures consistent assessment. The overall study process is depicted in Figure 1.

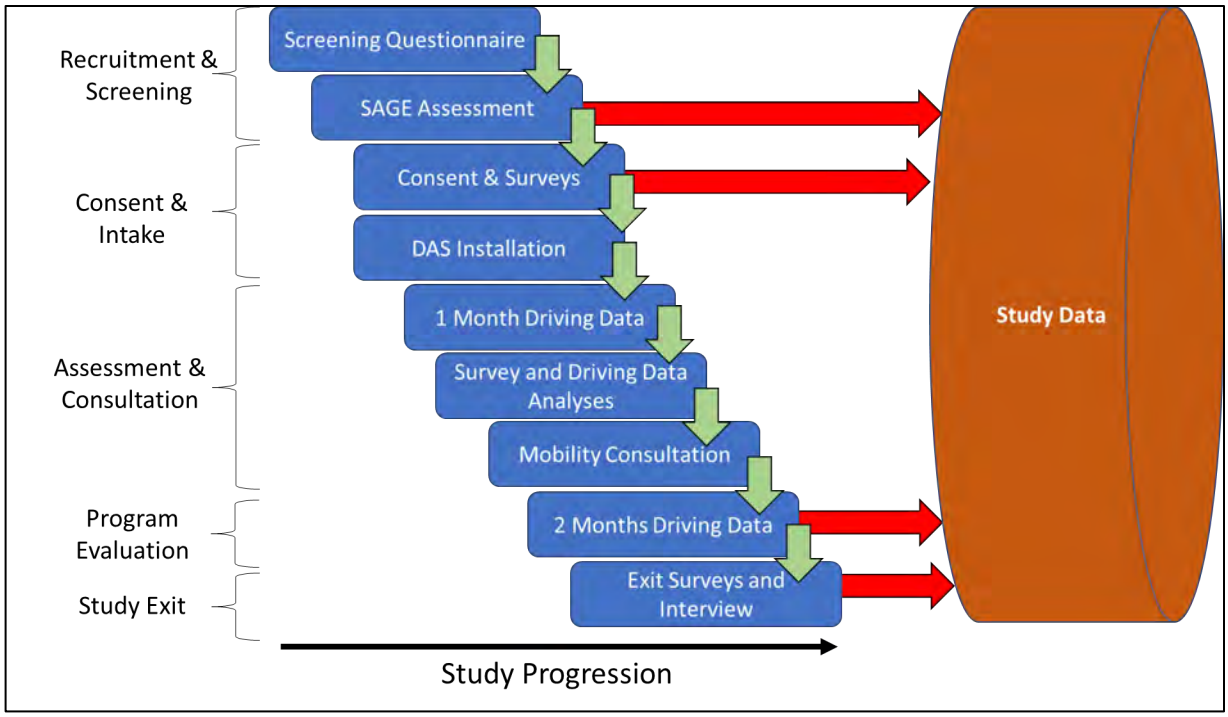

Figure 1. Study procedure

The SAGE was scored to determine suitability for inclusion. Possible scores on this instrument are 0 to 22. Totals of 11 and above were selected as the criterion for study inclusion (Scharre, 2007; Scharre et al., 2010). Appendix B provides a copy of the assessment and scoring rubric. Following scoring, the participant was either politely dismissed (by noting ineligibility to continue) and paid for their time or scheduled for an informed consent session. To mitigate the risk of additional exposure associated with asking the participant to drive to VTTI, and to ensure participants felt both comfortable and secure, the research team conducted remote informed consent sessions.

Informed Consent

Participants were guided through the informed consent process, provided an opportunity to sign, and completed additional assessments (described below). Simultaneously with these assessment activities, as soon as informed consent was granted, VTTI's data acquisition system (DAS, described below) was installed in the participant's primary vehicle to collect in situ driving data.

Following the informed consent session, participants were introduced to the DAS equipment installed in their vehicle, and any concerns were addressed. Participants were instructed to drive for the next month as normal. This month of data collection would be used in conjunction with survey responses to form the basis of the creation of a tailored mobility solution. Customized solutions were informed by the output from a custom-designed algorithm that used survey responses as input and suggested interventions according to predefined criteria.

Mobility Consultation

The mobility consultation occurred at the participant's home or a third-party location as preferred. At this session, the researcher reviewed the algorithm output with the participant, noting any results identified as potential areas to bring to the participant's attention. For each result identified, an accompanying intervention was prescribed. Note that participants were not required to follow the given

intervention to continue in the study but were encouraged to do so. For the next 2 months, participants continued driving their primary vehicle as they did for the first month in the study, generating post-mobility consultation driving data for program evaluation. After the remaining 2 months of naturalistic data collection, the research team once again visited the participant's home or third-party location to remove study equipment and administer post-study questionnaires and interviews.

Assessment Selection

Figure 2 highlights the primary components of the assessment selection process. Initially, the team began with an inclusive approach, gathering a broad range of potential assessments from peer-reviewed sources, hospitals, clinics, and advocacy websites. The team then applied several criteria to select the most suitable assessments. Only those that (1) were empirically relevant, (2) provided actionable outcomes, (3) were feasible to implement, (4) were able to be replicated across research sites, and (5) could be completed with a nominal time commitment by older adults were adopted. These criteria were selected to determine assessments that were highly relevant and would enable future expansion at sites away from VTTI. The resulting eight assessments are represented in four categories: (1) physical fitness, (2) health, (3) preferences and access, and (4) knowledge. Note that in many cases, questionnaires were adapted from their cited sources and/or combined with others to fit the needs of the current effort. Additionally, the research team created custom questionnaires to capture additional important information. Each of the assessments below is presented in full in Appendix C.

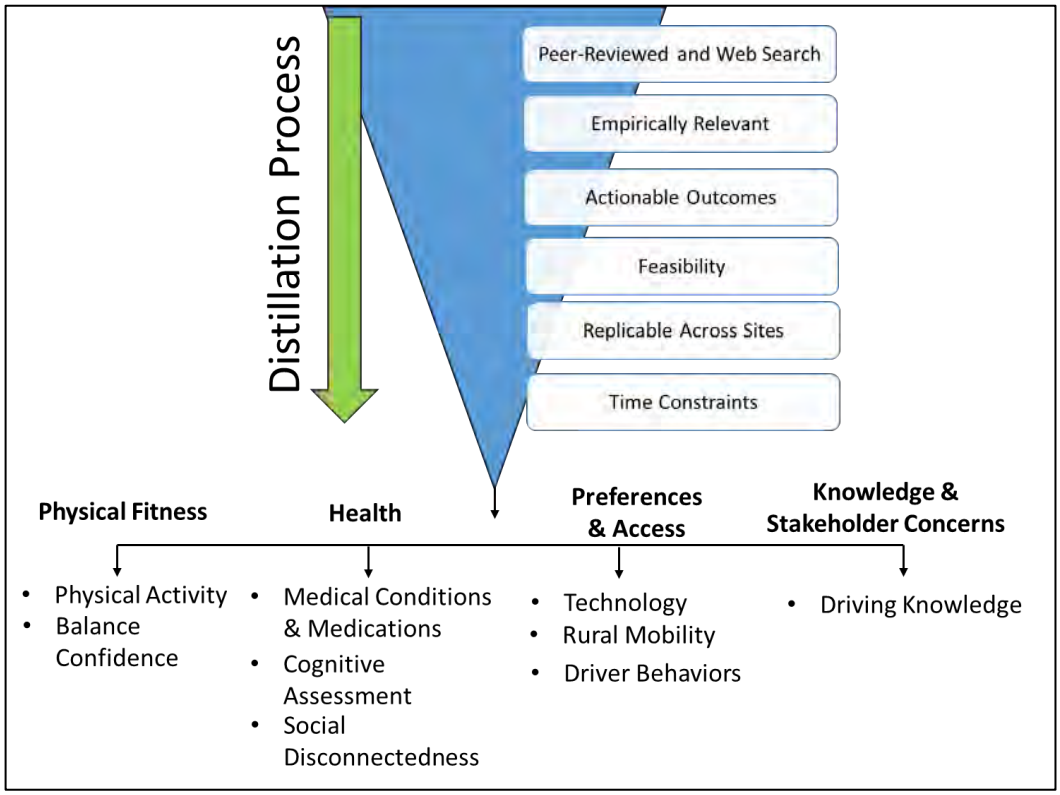

Figure 2. Assessment selection process.

- **Physical Fitness**
  - *Physical Activity* – variety, intensity, and frequency of physical activity; adapted from Cho (2016)

- *Balance Confidence* – balance confidence in several real-world situations; adapted from Powell and Myers (1995)

- **Health**
  - *Medical Conditions and Medications* – focuses on identifying medical conditions or medications that may have an impact on driving; adapted from Dingus et al. (2014)
  - *SAGE* – a self-administered pen and paper assessment that combines several cognitive assessments such as trails-making, memory recall, clock drawing, and visualizing missing information (Scharre, 2007)
  - *Social Disconnectedness* – focuses on the number and quality of social relationships; adapted from Cornwell and Waite (2009)
- **Preference and Access**
  - *Rural Mobility* – focuses on access to alternative transportation, situational avoidance, technology use and comfort, and supplemental assistance; adapted from National Center for Mobility Management (n.d.)
  - *Driver Behaviors* – focuses on driving-related difficulties and level of independence; adapted from Eby et al. (2008)
- **Knowledge**
  - *Driving Knowledge* – correct roadway sign identification; adapted from *Road Signs Mini* test on https://driving-tests.org/virginia/

Intervention Selection

A similar process to the one described above for survey instruments was applied to potential interventions (Figure 3). The initial search intended to include potential interventions with the understanding that the same filters would be applied to focus on those best-suited for the current work. Again, these filters focused on interventions that (1) were empirically relevant, (2) provided actionable outcomes, (3) were feasible to implement, (4) were able to be replicated across research sites, and (5) could be completed with a nominal time commitment. The resulting 25 interventions were sorted into five overarching categories: vehicle-based, restrictions & routing, education & training, VTTI-derived interventions, and referrals.

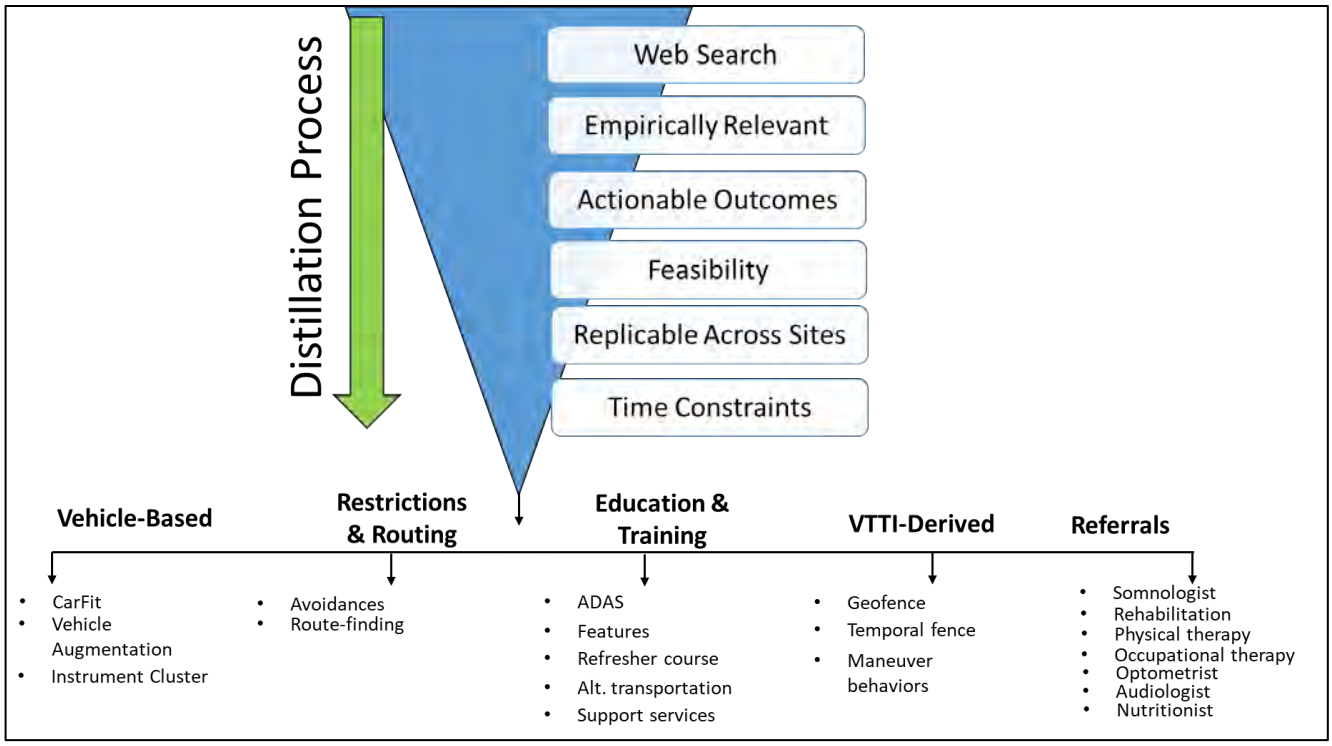

Figure 3. Intervention selection process.

A description of each of the interventions is presented below and where applicable in Appendix D.

- **Vehicle-based**
  - *Vehicle Augmentation* – alternative tools such as large rearview mirrors, convex mirror attachments, pedal extenders, or steering wheel knob
  - *Instrument Cluster Configuration* – configuration of the vehicle's instrument cluster to reduce workload or provide improved information presentation
- **Restrictions and Routing**
  - *Route Finding or Avoidances* – use of a navigation system or suggested route changes (such as three rights instead of a left turn), may include avoidance of situations, specific times, or scenarios in which the older adult finds it difficult to drive
- **Education and Training**
  - *Advanced Driver Assistance Systems (ADAS)* – use of advanced driver safety features such as adaptive cruise control or lane centering
  - *Standard Features* – use of standard features such as blind spot alerts or lane departure warnings
  - *Driver Refresher Course* – a driving school dedicated to assisting older drivers with skills retraining or retention
  - *Technology Training* – basic technology training on navigation systems (e.g., phone, in-vehicle, and/or nomadic)
  - *Alternative Transportation* – overview of how to use local alternative transportation options, including busses, and ride-share modalities
- **VTTI-derived Discussions**
  - *Safety Discussion* – discussion predicated on driving behaviors noted in the naturalistic data review or called out in a survey item

- **Referrals to Discuss with Primary Care Physician**
  - *Somnologist* – for sleep or drowsiness issues and concerns
  - *Driver Rehabilitation* – rehabilitation specialist if recovering from a physical or cognitive impairment
  - *Physical Therapy* – rehabilitation or improvement of physical fitness
  - *Occupational Therapy* – training or rehabilitation required due to a physical or cognitive impairment
  - *Neurologist* – for further evaluation of cognitive issues or complaints
  - *Audiologist* – for hearing evaluation and the potential implementation of hearing devices
  - *Nutritionist* – for nutrition information to help control blood sugar or other factors which may affect driving safety
  - *Optometrist* – for vision evaluation and the potential implementation of vision correction
  - *Counselor* – referral for those who have difficulty navigating an emotional condition or situations that affect driving

Additionally, several other relevant sources of information were compiled to be shared with the participant (both in paper and digital format – Appendix D):

- **Local alternative transportation options**
  - Public transportation offerings, ride-share, etc.
- **Local support services**
  - Local area agencies on aging, non-profits, transportation centers, etc.
- **Older driver informational websites**
  - Seniorliving.org, skillfulsenior.com, aginginplace.org, health and wellness websites, driving resources, etc.
- **Older adult centers**
  - Local recreation and senior centers
- **Library resources**
  - Contact information for local libraries
- **Post-crash information related to ADAS**
  - Information about various ADAS and how they are affected in a crash
- **Driving cessation resources**
  - Dementia and driving, how to have conversations about not driving, driving contracts, etc.
- **Co-pilot infographic**
  - VTTI-created infographic with information regarding beneficial characteristics of a good co-pilot
- **CarFit session**
  - Educational program designed to help fit the older driver to their vehicle. Each session was completed by a certified CarFit technician. In addition to the standard CarFit protocol, the researchers utilized demonstrations of in-vehicle technology where feasible (e.g., a box placed near the rear bumper of the vehicle during backup camera training).

Algorithm

Survey Data

A custom algorithm was developed to integrate and analyze data collected from surveys and driving data. Using Microsoft Excel to score select answers from questions across survey instruments, the

research team was able to integrate disparate findings into a single concise output for each potential intervention. For example, nine questions from two surveys that may be relevant to an older driver who may benefit from a visit to a sleep physician are scored and combined into one metric. For that intervention, a score of seven or higher was selected as a criterion to suggest speaking to a sleep physician. When a participant's score met the criterion, a flag was applied to output as a signal to discuss sleep-related issues with the participant during the mobility consultation. A conceptual example showing the allocation of scoring into different interventions is presented in Figure 4, while an actual example of the process which led to a discussion surrounding night driving is presented in Figure 5.

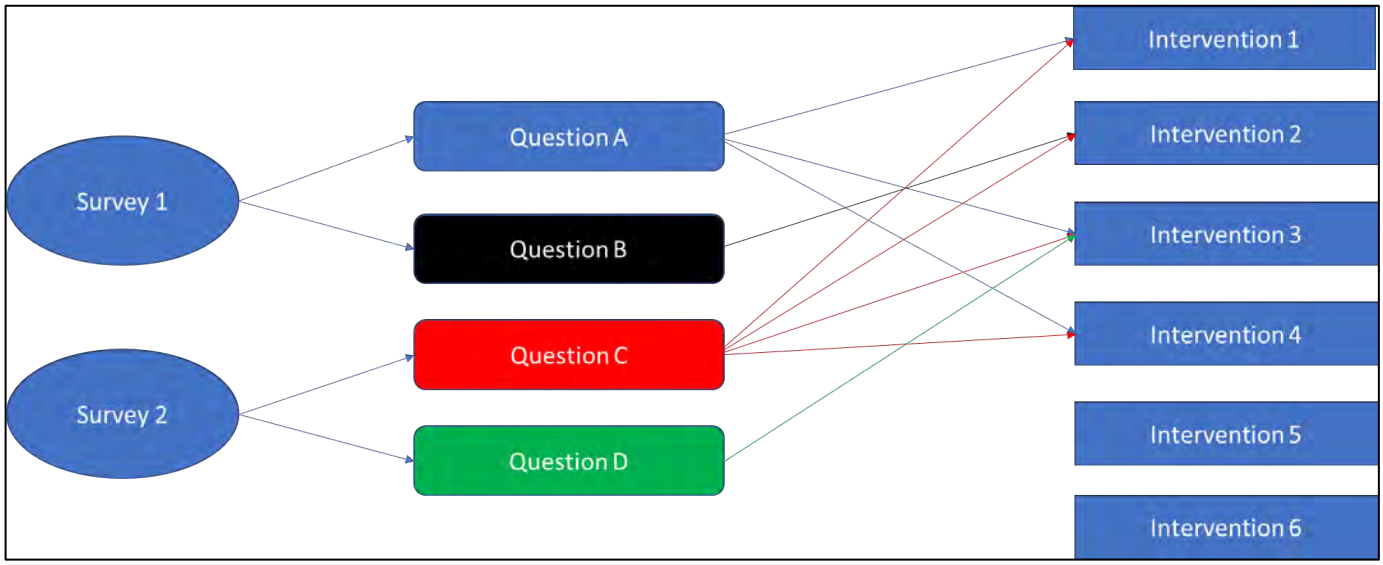

Figure 4. Generic example showing how multiple questions from multiple surveys can lead to a variety of interventions or none.

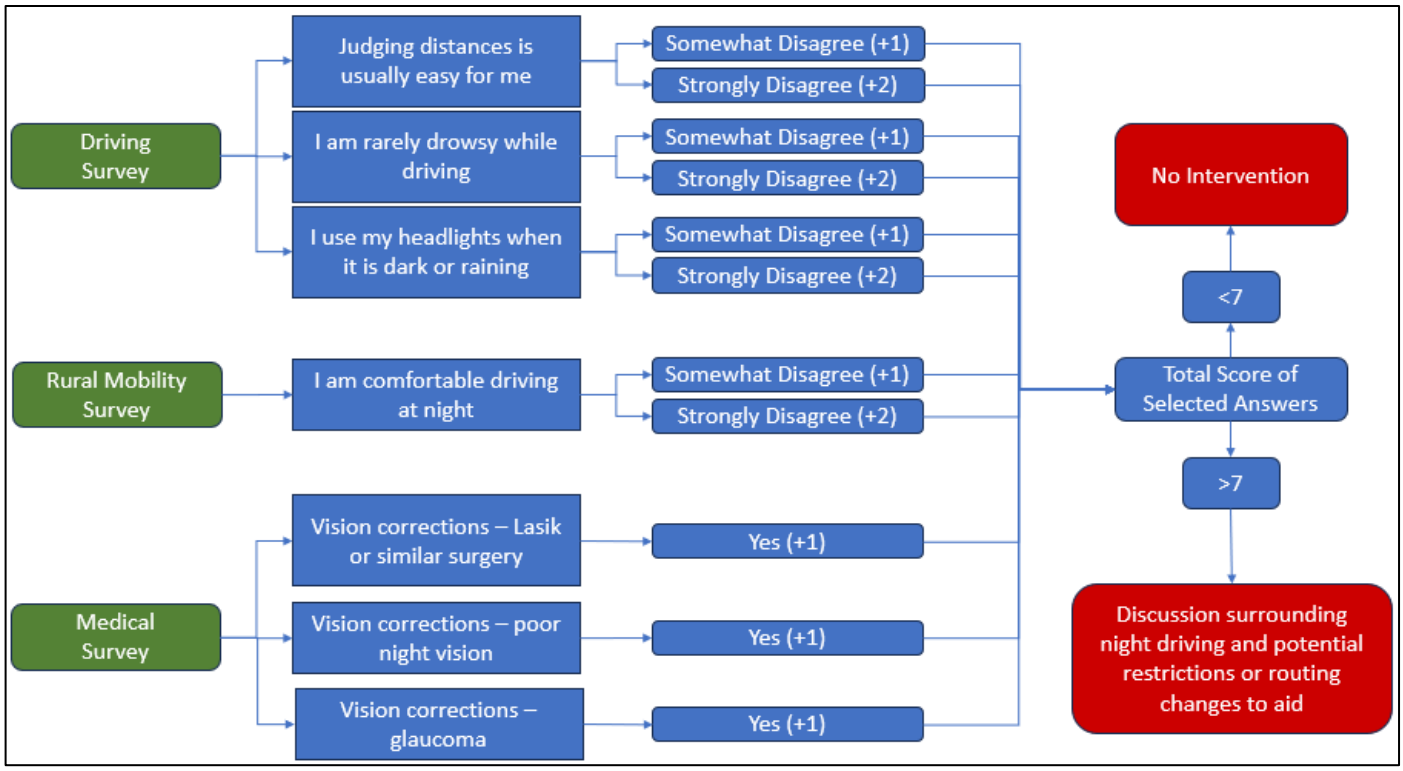

Figure 5. Algorithm example depicting the process to determine if a discussion surrounding night driving is warranted.

Mobility Consultation

Following analysis of the assessment data and based on the output of the algorithm described above, the research team developed a set of recommendations tailored to that participant's situation and expressed concerns. We then scheduled and conducted a mobility consultation with the participants at their home, VTTI, or a third-party location, as per their preference. The purpose of this consultation was to present the participant with the results returned from analyses and to engage in a conversation about any noted items of concern. Note that the algorithm served as a series of jumping-off points for further discussion. Oftentimes, novel concerns, as well as their associated recommendations, arose organically from these fruitful discussions. The research team spoke with the participant to gain further insight into any items of note and, where appropriate, suggested interventions were presented. Throughout the process, the participant was encouraged to provide additional input and to voice other concerns not otherwise covered. Participants were encouraged to consider exploring each recommendation to see if it might prove beneficial. A subset of an example participant output is presented in Figure 6, while a complete example is provided in Appendix E.

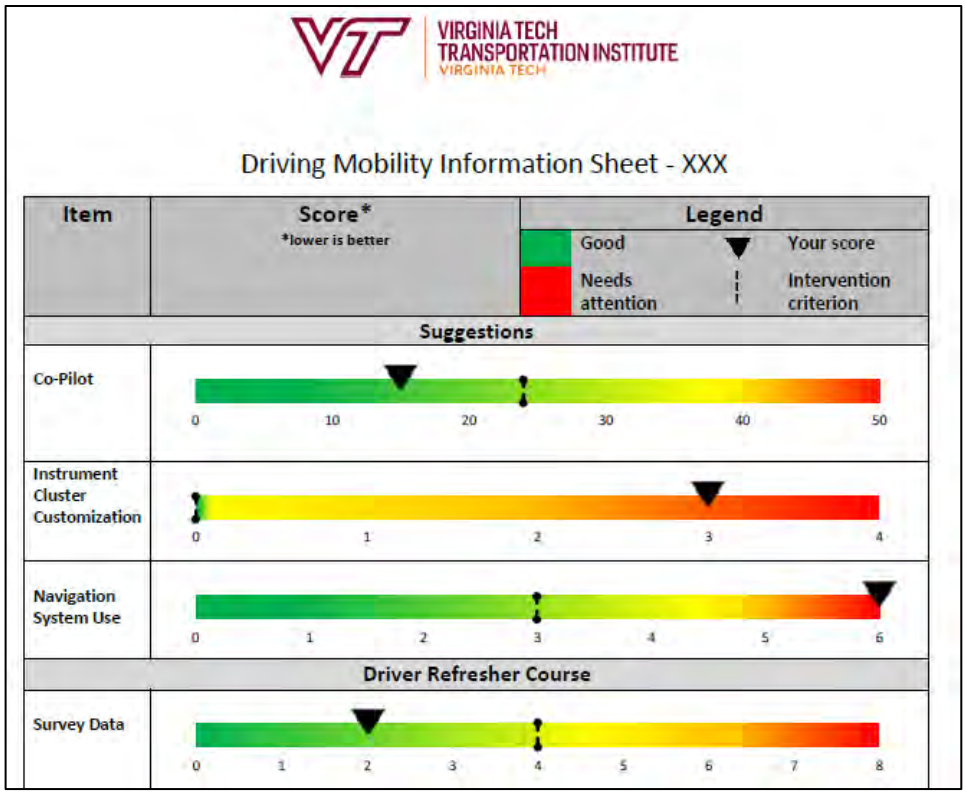

Figure 6. Example portion of algorithm output.

Planned Intra-study Evaluation

Following the first four pilot participants, a planned intra-study evaluation was conducted. The researchers made a few alterations to the process. While most content remained unchanged, some new questions were introduced to the assessment process to capture information lacking previously, while others were struck from the process or edited to streamline data collection and clarity. The additions primarily focused on past crashes, the use and effects of a co-pilot, and concerns about walking to a destination should distant parking be required. Additionally, a self-assessment was included. The measurement of physical capabilities was also introduced at this point. Following is a description of the elements that were added at this time.

Balance and lower body strength. A metric was included to assess lower body strength and balance. The chosen test was the semi-tandem stand completed for time in which the participant stands with the heel of one foot adjacent to the big toe of the other foot (Guralnik et al., 1994, Figure 7). The current version was chosen as it was believed to be safer than a rapid pace walk, sit-to-stand, or the one-legged balance assessment. Scores are based on the duration the participant can maintain balance without grasping for the provided safety structure (i.e., a walker).

Figure 7. Semi-tandem foot placement is used in the balance and lower body strength assessment.

Upper body strength. The Jamar hand dynamometer was chosen for a gross approximation of upper body strength. A single measurement from each hand was recorded and the participant was given verbal encouragement (Figure 8, National Academies, 2015).

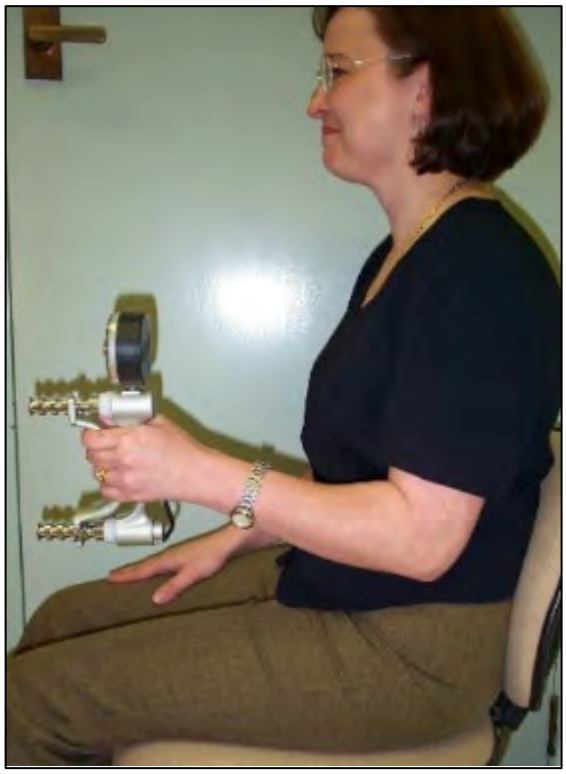

Figure 8. Standard grip strength testing position.

Flexibility. A measure of upper body flexibility was added to the process and was collected while the driver was seated in the driver's seat of their vehicle with hands on the wheel. The participant was asked to look over their left shoulder (as they would do during a lane change) while keeping their

hands on the steering wheel without allowing a position change or rotation of the pelvis (Figure 9). The metric that was recorded was based on the angle change from straight ahead to the furthest extent the driver could perform (using their nose as the marker) into one of the following categories: between straight ahead and the side mirror, between the side mirror and shoulder, and past the shoulder.

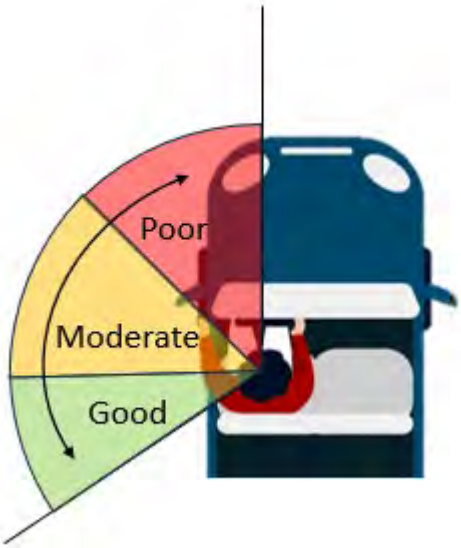

Figure 9. Upper body flexibility assessment.

Reaction time. A simple online reaction time assessment developed by researchers at the University of Washington was utilized (https://faculty.washington.edu/chudler/java/redgreen.html, Figure 10). It required the participant to press the space bar or click a mouse in response to a displayed traffic light change. An average of five trials was used, and the participant was allowed to practice until they understood the task.

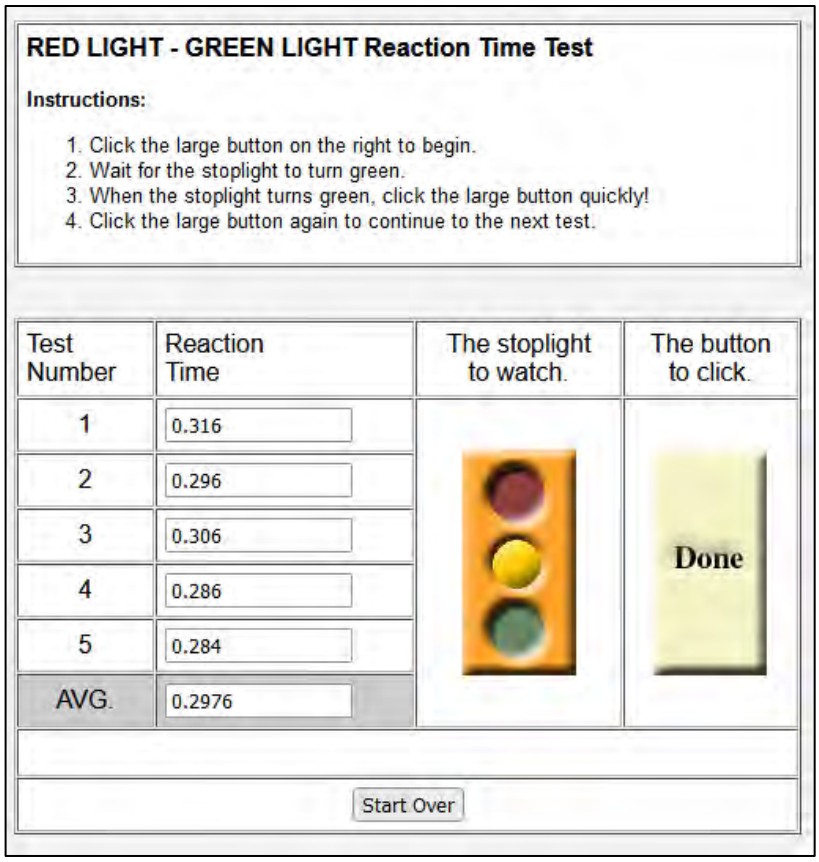

Figure 10. Washington University web-based reaction time assessment.

Contrast sensitivity. A SpotChecks™ contrast sensitivity (CS) assessment required the participant to mark one of three possible locations where a gray circle of diminished contrast is presented. As the assessment continues, the circles' contrast is reduced, making detection more difficult (i.e., requiring greater CS to detect the circles' correct location. The assessment concludes when two consecutive incorrect marks are made, and the participant's score is expressed as LogCS value of the last correct mark. Example cells are shown in Figure 11, while instructions and scoring protocols are presented in Appendix F.

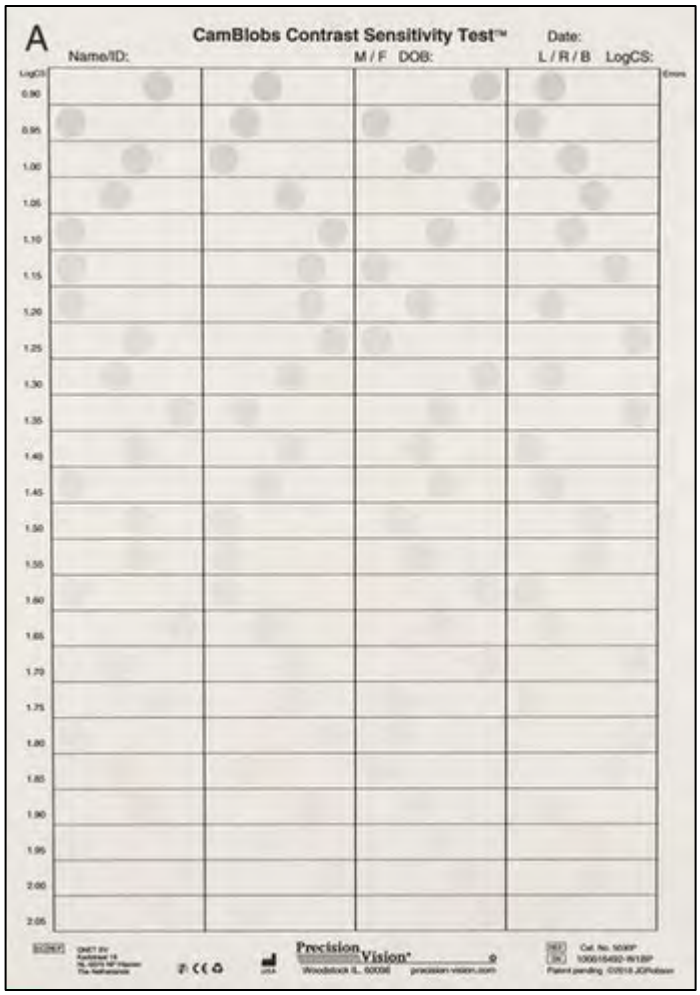

Figure 11. Example contrast sensitivity assessment.

Data Acquisition System

To capture driving behavior, a VTTI DAS was installed in the participant's primary vehicle. This hardware consisted of sensors (GPS, accelerometers, gyroscopes), video cameras (forward, face, and two of the following: rear, instrument panel, turn signal stalk, or over-the-shoulder view), and connection to the vehicle network. The DAS continuously collected data from key-on to key-off, less 30 seconds of start-up time. An example of video views is depicted in Figure 12.

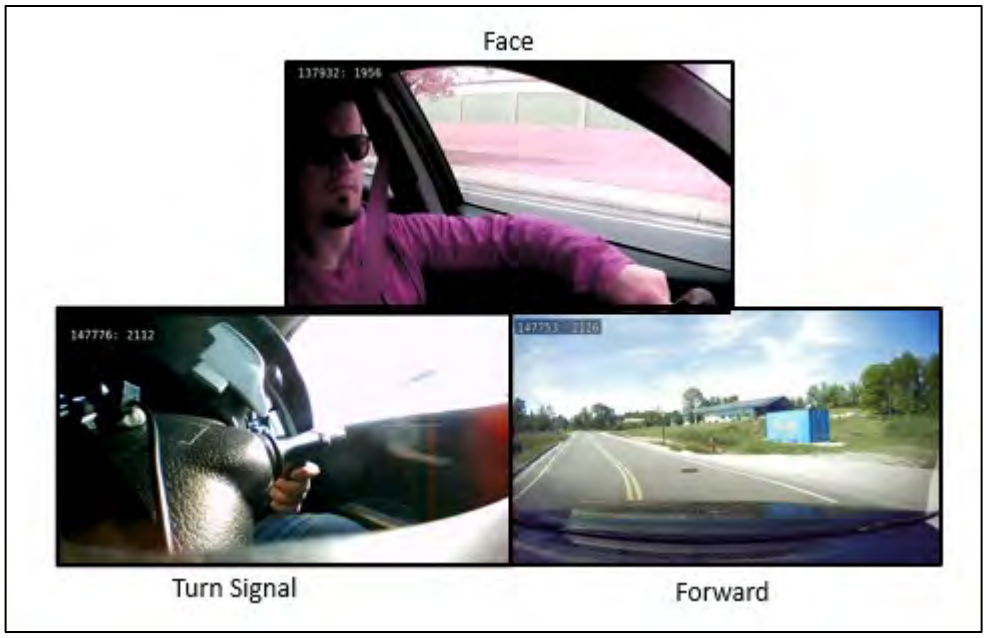

Figure 12. VTTI DAS camera views.

The DAS is designed to be unobtrusive. The main unit is mounted under the dash in the footwell of the vehicle so it is out of the way of the participant's feet (Figure 13). The encrypted USB hard drive is remotely mounted in the glove box for easy replacement. Sensor data were collected at a rate of 10 Hz, while vehicle network data varied by source but were most often collected at 10 Hz or higher frequency.


Figure 13. Main unit of the VTTI DAS mounted in the driver's footwell.

Driving Data Scoring for Consultation

To score the driving data, the research team developed a protocol that enabled a time-efficient review of the data in several key areas:

- Traffic control device attentiveness
- Intention signaling
- Proper headway in turns
- Lane control
- Speed maintenance

- Steering steadiness
- Situational awareness

The sampling strategy was to locate four of each event type (such as lane changes, left turns, right turns, backing, etc.). For each trip, the goal was to limit the analyses to one event of a given type: for example, no more than two lane changes within a given trip were evaluated. Intersection events were limited to two stop-sign-controlled intersections and two light-controlled intersections, while lane changes were evenly split between left and right. Finally, any notations of secondary task engagement were limited to those surrounding one of the other events. In addition to the above analyses, the research team coded lighting and weather conditions for each event. Output from these driving data analyses was also utilized as an input to the algorithm noted above.

By utilizing the driving data, the research team was able to identify and analyze scenarios that may prove difficult for older adults. For instance, during lane changes, the team could use video views to determine glance behaviors before and during the maneuver, as well as turn signal use. During interactions with stop signs, the team could rely on accelerometer data to determine braking aggressiveness, video views for glance behavior to locations that may contain other threats, and rule-following. As such, the research team leaned heavily on the experienced transportation safety analyst's understanding of the integrated combination of sensor and network data alongside video views to evaluate the participants' driving behaviors, quirks, and problems.

PHASE 1 RESULTS

Interventions

During Phase 1, a more detailed exit interview took place in which the research team investigated subjective reports for each of the interventions offered. Where appropriate, a parallel analysis was conducted using naturalistic driving data. A breakdown of the distribution of interventions across participants is detailed in Appendix G, while details of the sampling method for the naturalistic analysis are presented in Appendix H.

CarFit

As part of the program, all 10 participants received CarFit adjustments, and all 10 felt the process was beneficial to their safety and/or confidence. Nearly all participants stated that the side mirror adjustments improved their visibility, but it is worth noting that in one case the participant felt a decrease in confidence until she became accustomed to the different positioning. Seating position and steering wheel adjustments were also well received, with five participants saying they now felt safer. One participant noted the adjustments to the seating position had a particularly large impact on her—she no longer has foot cramps from stretching to reach the pedals and no longer has shoulder pain from the steering wheel position.

Alternative Routing

The most common alternate route suggestions were avoiding high-speed roadways or complex intersections. However, of the nine participants receiving suggested alternative routes, only three stated using them as an option. In many cases, the participant already knew about the option (three participants), or it was in an out-of-town location they had not yet visited (three participants). Finally, two participants liked the alternative route suggested *and* were unaware of its existence previously. Given the study location in rural southwest Virginia, alternative routes are not always feasible or abundant.

Naturalistic data proved useful in evaluating the use of alternative routes via GPS coordinates. As was expected, participants expressed difficulties on a variety of routes, many of which included more remote destinations. However, as these locations are traveled less frequently, we are less likely to see the alternate routes confirmed in the 2-month data collection window. Only two of the nine participants who received an alternative route intervention found the alternative route useful *and* were previously unaware of it. Of those participants, both were witnessed using the alternative via GPS data. One participant noted the usefulness of the out-of-town suggested route; however, GPS traces were not able to verify he had used it at the time of study exit.

Secondary Task Engagement

A discussion surrounding secondary task engagement occurred for six participants. In three cases, this was more of a reminder that snacking or drinking does momentarily reduce attention to the driving task; however, in the other three cases, the tasks engaged in were more egregious from a distraction perspective, such as flossing, eating a hamburger, or interacting with a phone. These instances led to more involved and pointed discussions about the increased risk associated with these sorts of secondary distractor tasks. These more-involved discussions focused on why a particular behavior may increase crash risk and included specific examples from their driving data. Participants appreciated the

discussion and felt it was beneficial to help them remember and rededicate themselves to the safe driving practices of which they were already aware but had shifted away from over time. On the other hand, one participant dismissed the finding that he engaged in secondary tasks, and one participant was only willing to admit that his phone use may be risky but not his flossing.

Naturalistic results on tasks per 30-second segment showed a decrease in secondary task engagement for half of the participants. Together, a minor drop of 0.3 tasks per segment was seen. Table 2 shows the pre- and post-consultation rate of engagement in secondary tasks.

Table 2. Secondary Task Engagement by Participant

Pre/Post Consultation	Mean (s.d.)	Range
Pre	3.0 (1.2)	1.7-5.1
Post	2.7 (1.1)	1.6-4.8

Phone Connectivity

Another frequently used intervention involved phone connectivity with the vehicle, either through Bluetooth pairing or the use of Android Auto/Apple CarPlay. In some cases, participants were unaware they could connect their phone (either via Bluetooth or Android Auto/Apple CarPlay), or they had tried to do so but were unable. VTTI researchers were able to pair one participant's phone to his vehicle's Bluetooth. He knew his vehicle had the capability but was unaware of how to go about pairing the phone himself. If he chooses to use his phone, he no longer needs to hold it in his hand or balance it on his lap. One participant's vehicle had Android Auto capabilities, but she was unaware of the technology. Pairing the phone with her system allowed for hands-free calls, as well as native navigation directions on the center console. She was ecstatic to have that functionality available.

Physical Therapist

Four participants engaged in a discussion related to a physical therapist. In some cases, these discussions resulted from poor performance on the physical assessments (e.g., grip strength or range of motion), while others came from the participant noting painful sensations while driving. While all four felt the discussion was beneficial, only one had sought out a physician to discuss by the time of study exit. This may be due in part to the 2-month duration between the consultation session and the exit interview but may also be indicative of a larger commitment that would be required to seek out such help.

Prior Crash

Three participants brought up a prior crash and how the crash affected their confidence in driving. Participants felt the conversation was beneficial in that it helped to better understand the crash and contributing factors. This helped to refocus the participants on maintaining safe driving practices. Additionally, participants stated that they were thankful for simply having the conversation. It allowed them to express their negative emotions and lingering effects. In each of the cases, VTTI researchers mentioned seeking out a counselor to work through lingering effects. At the time of the study exit, none had yet done so. After the initial four participants, VTTI researchers quickly became aware of the importance prior crashes played in participants' current driving schema. As a result, the researchers added survey questions related to prior crashes.

Seat Belt Use

In three instances, participants volunteered information about their seat belt habits. They admitted to not using their seat belt on short trips or failing to engage the belt until after a few minutes of driving. The conversation focused both on awareness as well as the safety benefits of belt use.

Neuropathy

Three participants noted that they experienced neuropathy. During the consultation session, researchers attempted to determine the extent and degree to which it affected their driving. In no cases was neuropathy affecting the participants to the degree they felt it was worth speaking to their primary care physician about.

Drowsiness

Two participants took part in a discussion related to drowsy driving. In both cases, participants noted increased awareness of their level of fatigue. One participant stated he began paying attention to his sleep quality rating from his CPAP machine as a data point for his quality of sleep. The participant's level of drowsiness was evaluated in two cases. On average, Observer Rating of Drowsiness (ORD) scores showed no meaningful difference between pre- (mean: 24.1, standard deviation: 6.3) and post-consultation (mean: 26.9, standard deviation: 9.3). It is worth recalling that ORD scoring is based on a scale of 1 to 100 and single-digit changes are unlikely to be of significance.

Traffic Control Device Attentiveness

Conversations surrounding full stops at stop signs were completed for two participants. Discussions were well-received; however, only one indicated the discussion was useful to her. Together, the percentage of fully complied with stop signs changed from pre- (mean: 25%, standard deviation: 7.1%) to post-consultation (mean: 44.2%, standard deviation: 27.2%).

In-vehicle Technologies

VTTI researchers engaged in discussions with participants about their in-vehicle technologies. In one case, the participant asked the researcher to show her how to use conventional cruise control. Three years after purchasing her vehicle, she was unaware of how to use this feature and was not shown at the time of purchase. At the exit interview, the participant expressed gratitude for showing her how to use the system and for how much easier it makes long trips. Another participant whose vehicle does not have any ADAS technologies (except for a backup camera) engaged the researcher in conversation about new and emerging systems in support of planned future vehicle purchases. She was grateful for the discussion and stated that she now knows what to look for. The final participant engaged in a discussion related to his lane centering system but was already somewhat familiar with the technology. The conversation centered on system alerts and what the participant felt was the lack of information presented to the driver. Of the four participants receiving backup camera training, every single one provided positive feedback ranging from greater intended use to surprise at the dramatic increase of visibility while using the rear camera. In this program, only one participant drove a vehicle equipped with modern ADAS technology.

A review of the naturalistic data revealed a moderate increase of 11.4 percentage points in backup camera use following the consultation. Table 3 below shows the pre- and post-consultation rate of backup camera use.

Table 3. Backup Camera Use by Participant

Pre/Post Consultation	Mean (St Dev)	Range
Pre	40.0% (31.3%)	6.7%–66.7%
Post	51.4% (32.5%)	12.9%–88.9%

Case Study Highlights

Given the heterogeneity of findings and recommendations across participants, a case study approach was chosen to describe the outcomes, both subjectively and using objective naturalistic data for those in Phase 1. In general, participants reported a universally positive outcome on the process and program. Outcomes as visible in the naturalistic driving data ranged from changes in the negative direction to changes in the positive direction and are discussed later. When collapsed across participants, these findings may get washed out, and the rich, *tailored* dataset that comes with each individual participant is obscured. In most cases, on a *per participant* basis, there was some form of improvement noted in at least one of the areas of focus. See Appendix I for a series of case studies for the first 10 participants.

PHASE 2 INTRODUCTION

Following Phase 1, the researchers sought to explore additional methods to facilitate broader dissemination of the program benefits. While Phase 1 showed several positive outcomes, the collection of naturalistic driving data and the associated data analyses required a significant commitment of study resources, limiting the possibility of footprint expansion. Further refinement of the program represented an attempt to streamline the approach without losing the noted benefits.

To this end, Phase 2 retained the overall methodology of Phase 1 with the following alterations. First, the naturalistic data collection was replaced with a scripted test route driven by the participant with onboard experimenter-raters. Later, the test route was replaced with a smartphone application (or "app"), recording kinematic events. Both of these methodologies are explicated below. Further, the hands-on CarFit session was replaced with a video playlist covering CarFit basics. Each of these was part of the overall attempt to reimagine the program in a way where its footprint could be greatly expanded while leaving its positive core elements intact. Figure 14 depicts the conceptual progression of reduced complexity to meet increased dissemination.

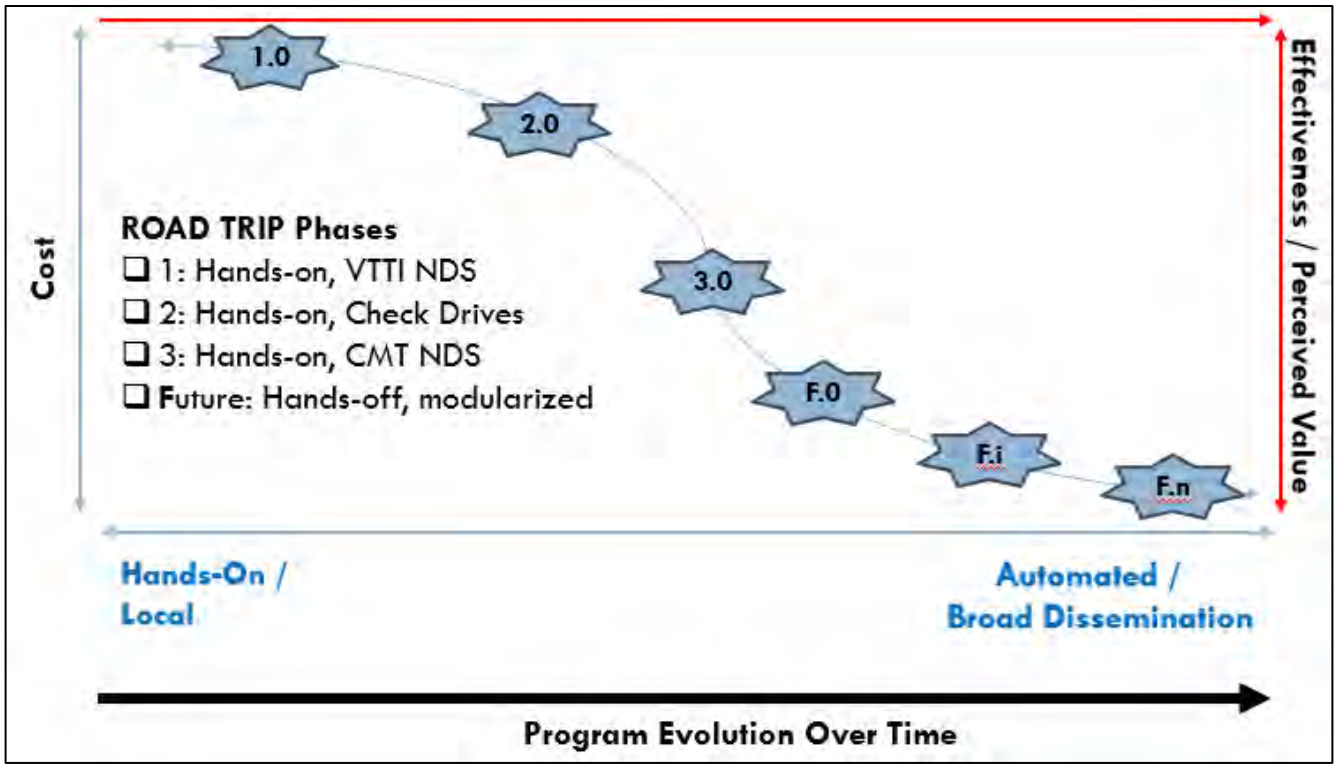

Figure 14. Conceptual figure highlighting the interplay between cost-intensive methodologies and broad dissemination.

PHASE 2 METHODS

Participants

A total of nine participants were recruited in this phase, each one expressing some level of difficulty related to achieving their mobility needs. Participant vehicles ranged from model year 2013 to 2021, with six of the nine vehicles newer than 2018. A breakdown of participant characteristics by methodology is presented below (Table 4**Error! Reference source not found.**). Phase 2 was approved by Virginia Tech IRB #23-598.

Table 4. Participant Gender and Age by Method

Method	Sex	N.	Age Range (mean)	Vehicle Year Range
Test Route	Male	1	74.0 (74.0)	2019
	Female	4	64-76 (69.0)	2013–2020
Smartphone App	Male	3	73-79 (76.7)	2013–2021
	Female	1	72.0 (72.0)	2018
	Total	**9**	**64-79 (72.4)**	**2013–2021**

Procedure

Driving Assessment: Test Route Procedure

The driving assessment route was designed to expose the participant to a variety of traffic control and roadway scenarios in the New River Valley area of Virginia (Figure 15). While the full test drive was

approximately 30 minutes in duration, an initial screening test route was completed at the outset. This allowed researchers to judge the driving fitness of participants during a very brief and relatively low-risk route prior to continuing onto the full route. If the researcher did not feel comfortable with the participant's driving, a bail-out point was defined, whereby this protocol could be curtailed in a relatively safe way before entering the full test drive route.

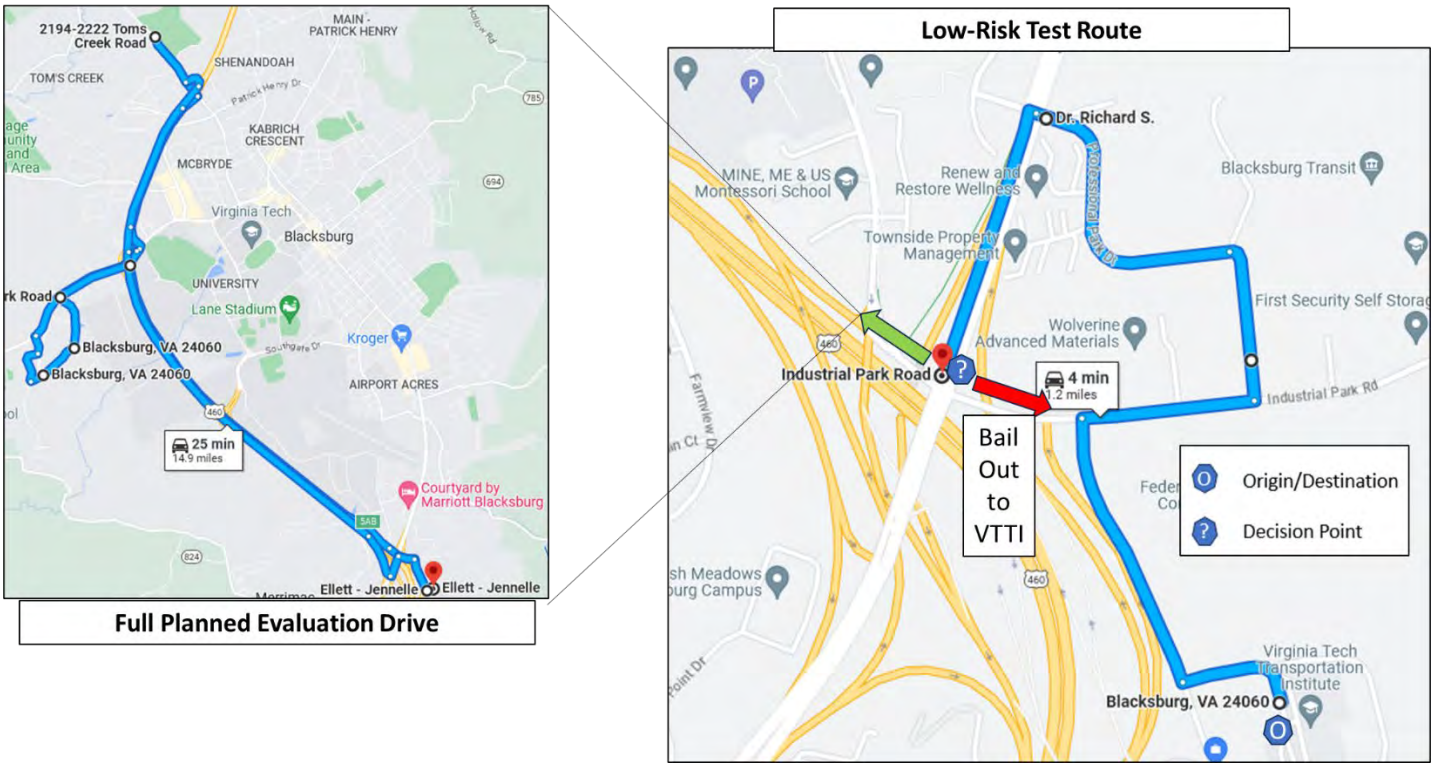

Figure 15. Full test route (left); bail-out option pre-route assessment drive (right) – green = go onto complete test route; red = bail-out option, immediately return to VTTI.

Test Route Scoring

During the planned test route, the researchers scored participants on several driving dimensions and/or scenarios at multiple points using a *Very Unsafe* to *Very Safe* scale, which facilitated accurate scoring in a dynamic environment. The full scoring protocol used is presented in Appendix J.

- **Traffic control device attentiveness**
  - Traffic control device attentiveness was scored based on coming to a complete stop where appropriate and turn signal use.
- **Lane position**
  - Lane position was scored based on the driver's ability to keep the vehicle centered within the lane (or in a reasonable position) and the presence of any lane deviations.
- **Following distance**
  - Following distance was scored based on a subjective metric of whether the researcher felt they were traveling too close to the lead vehicle or were comfortable based on vehicle speed and traffic conditions.
- **Lane change/merge**
  - Lane changes and merges were scored based on turn signal use, mirror checks, over-the-shoulder glances, and ability to merge smoothly with prevailing traffic.

- **Situational awareness**
  - Situational awareness was scored based on the presence of glances to mirrors and locations of potential threats, that is, directions other road users are or may be coming from.
- **Speed**
  - Speed was scored based on adherence to the local speed limit with an allowed variability of 5 miles per hour both above and below the posted limit.
- **Driving aggressiveness/soundness**
  - Driving aggressiveness was scored primarily on the subjective ride quality due to harsh braking, harsh cornering, or heavy acceleration.
- **Crosswalks**
  - Crosswalks were scored when the participant encountered another road user either in or attempting to enter a crosswalk. In the absence of a pedestrian or cyclist, no score was assigned. Otherwise, adherence to legal requirements for vehicle-pedestrian interactions as well as stopping locations was assessed.
- **Left turn across path**
  - The two left-turn-across-path scenarios were scored based on the participant's gap judgment, that is, when executing the turn, an appropriate subjective distance was allowed.
- **Right-of-way**
  - Right-of-way was scored primarily based on a single four-way stop-sign controlled intersection. If no pedestrians or other vehicles were present at the time, no score was assigned. Otherwise, a score was assigned relative to the participant's progression through the intersection based on standard four-way intersection rules.
- **Backing behaviors**
  - At one point during the test route, the participant was asked to park their vehicle with the front end facing a row of trees in a public location. Upon leaving the location, mirror checks and glances to the rear vision camera system (if present) were scored. Glances to multiple locations, as well as to the rear vision system, before moving was considered *Very Safe*.

Driving Assessment: Smartphone App Procedure

The researchers utilized the *DriveWell Go* app, developed by Cambridge Mobile Telematics (CMT) to assess participant driving behaviors. An experimenter guided app installation on the participant's smartphone during the intake session. Participant-specific tokens allowed for the app data to be routed to a VTTI database and associated with the correct participant. The online portal for the *Drivewell Go* data is illustrated in Figure 16.

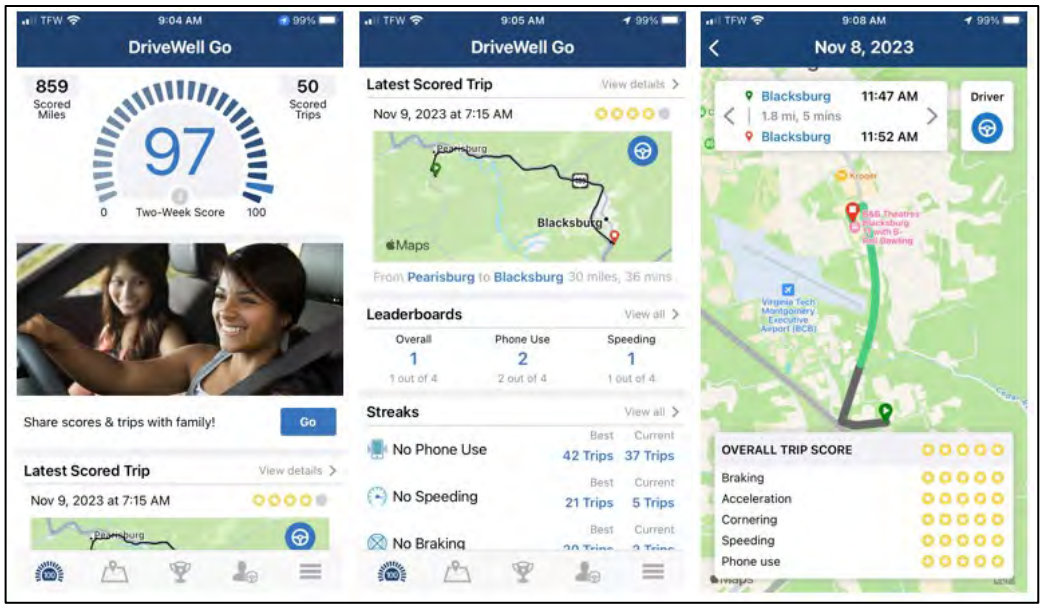

Figure 16. *DriveWell Go* app showing dashboard, trips, and trip details.

DriveWell Go datafiles contained geotagged drives and star ratings across several categories, including braking, acceleration, cornering, speeding, and phone movement. VTTI relied on these star ratings as the probe for potential discussion during the consultation session. As these star ratings were scored on a *per-drive* basis, it allowed researchers to not only present average ratings to the older drivers but the distribution of ratings across all drives. For both the test route and CMT data collection efforts, the goal was to focus on the collection of information to be utilized during the consultation session more so than providing pre- and post-consultation data.

CarFit

CarFit sessions conducted in Phase 1 took around 30 minutes, on average, and they were conducted by a certified CarFit Technician. As noted above, to streamline this process in Phase 2, a series of videos was viewed in lieu of such hands-on sessions. This also made it possible for those who are not CarFit certified to administer the consultation session. To these ends, a playlist of CarFit-produced videos was presented to participants (https://www.youtube.com/playlist?list=PL0j0MZD2EgjfcWiDUY9LQFwswGzqD2Upm). The video playlist walks the participant through an introduction to each of the key components of CarFit. Following the viewing, any questions or clarifications were addressed by personnel trained similarly to CarFit. If needed, the personnel worked with the participant and their vehicle until all questions were answered. In the event a question could not be adequately answered, a CarFit-trained researcher was available to assist.

RESULTS: PHASE 1 AND 2 INTEGRATED

Exit Survey

One survey item assessed the ability of the participant to get to needed locations without undue difficulty. After the consultation, 84% of participants noted they *strongly agreed* compared to 58% pre-consultation. It is also worth highlighting that one participant shifted from *somewhat disagree* to *strongly agree* following the consultation (Figure 17).

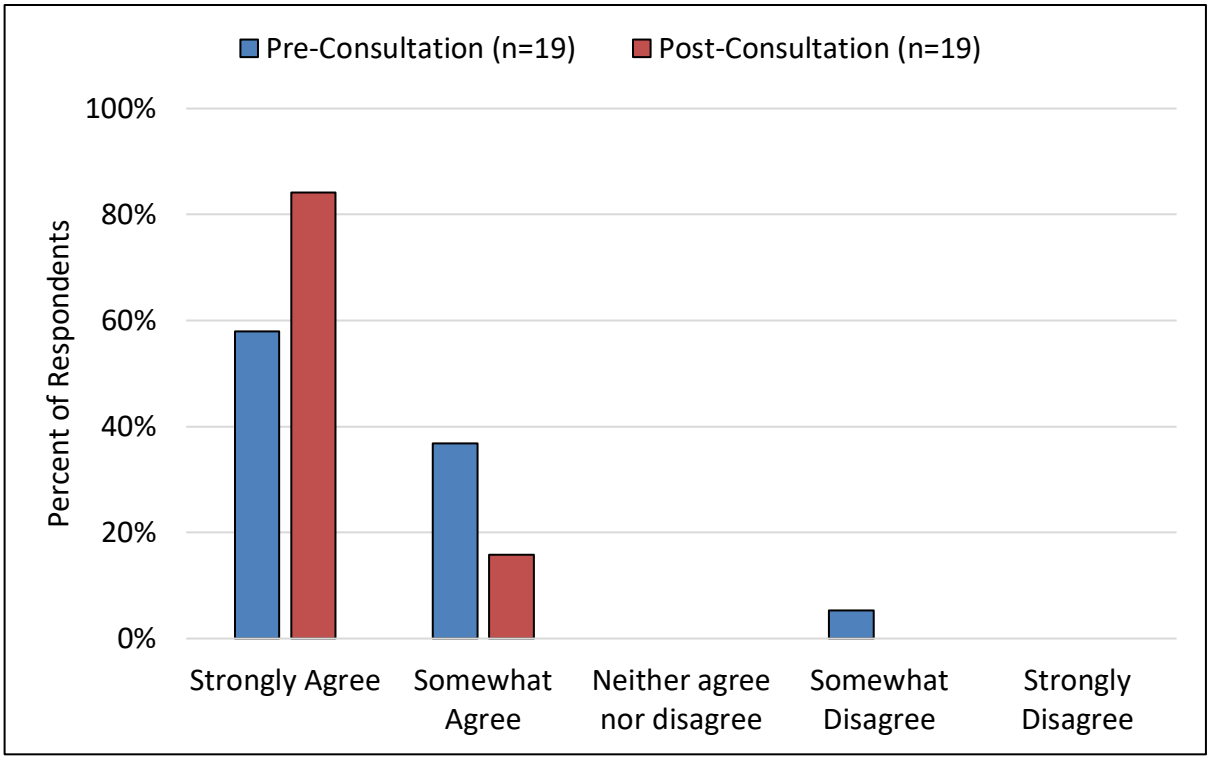

Figure 17. Ability to get to needed locations.

Other survey items assessed participants' ratings of their level of confidence, calm/relaxed driving, and rated level of driving safety. Prior to the consultation 50% of participants marked *strongly agree* to their level of confidence, while 63% did so following the consultation (Figure 18). Overall, there were minor changes in participants who *strongly agreed* (37% to 42%) to feeling calm and relaxed while driving and a decrease in those who *somewhat agreed* (58% to 42%, Figure 19). Participants' stated levels of driving safety did not demonstrate a change following the consultation session (Figure 20).

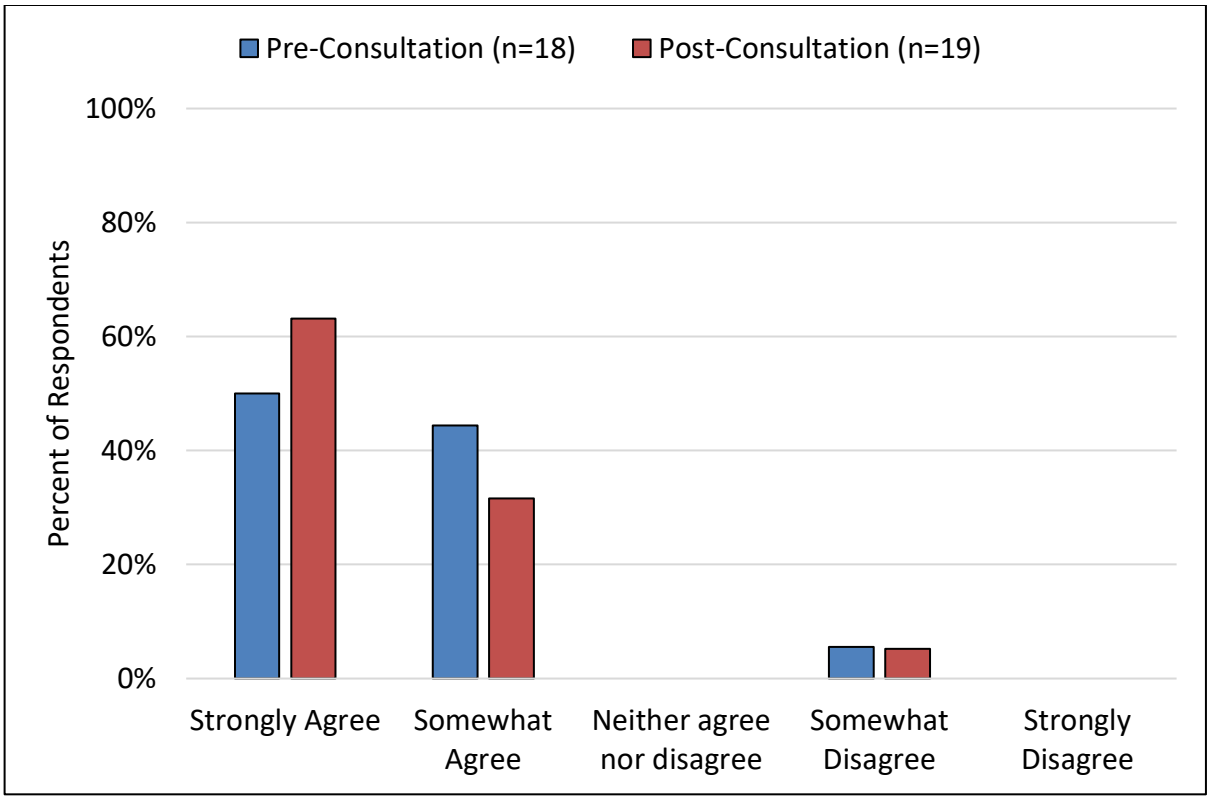

Figure 18. Level of confidence while driving.

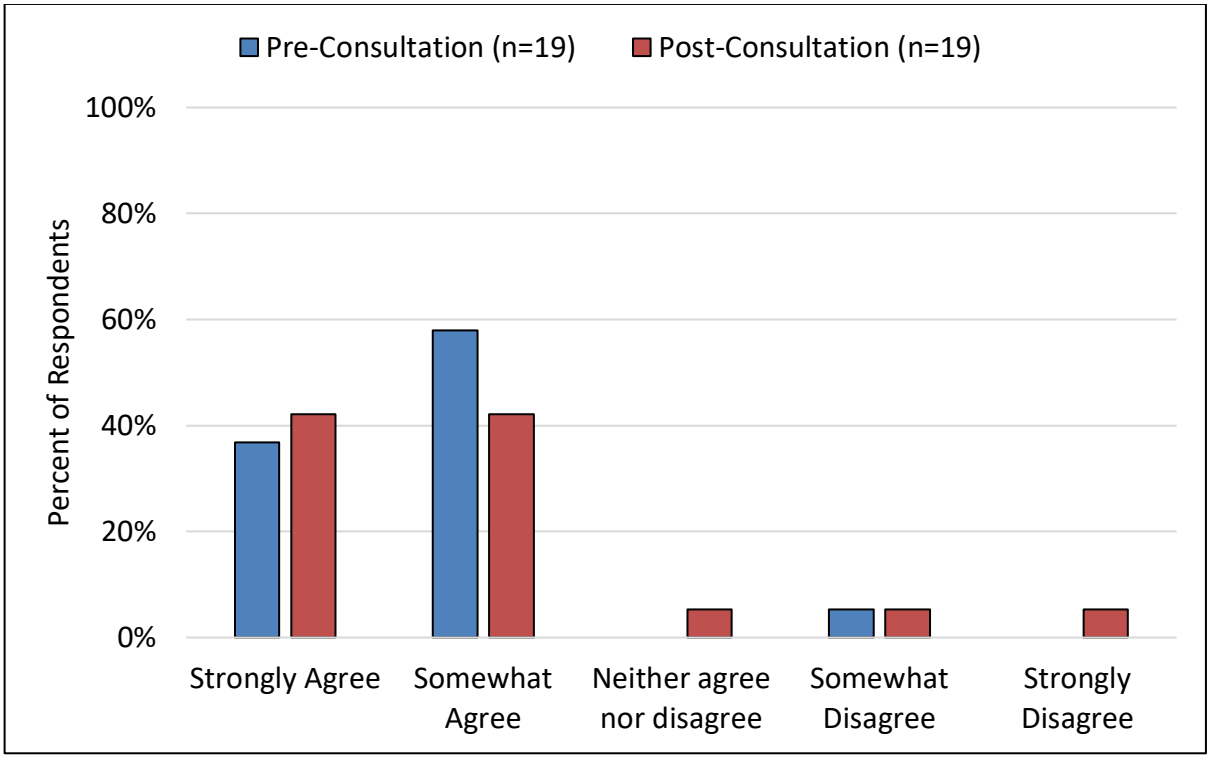

Figure 19. Feelings of calm or relaxation while driving.

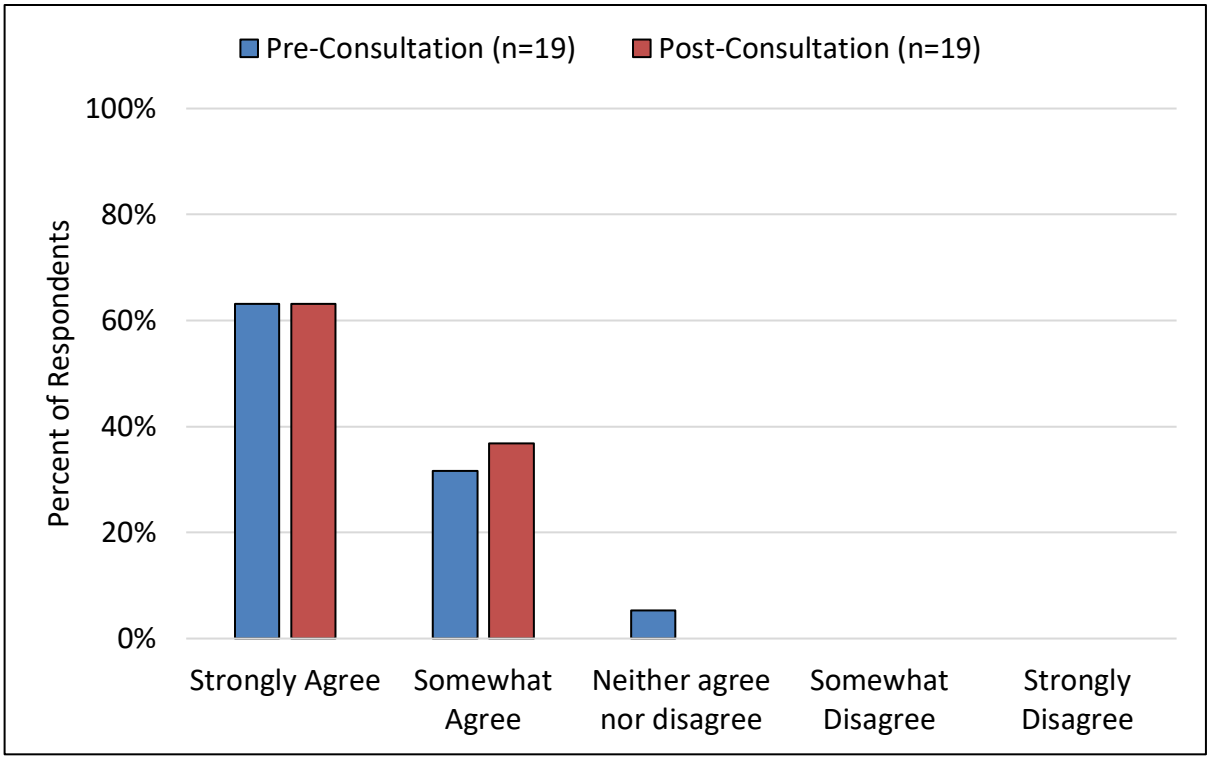

Figure 20. Feelings of seeing self a safe driver.

Participants' ratings of meeting planned (Figure 21) and unplanned transportation (Figure 22) needs showed increases in those who marked *strongly agree* to those needs being met. For planned transportation needs, the percentage who selected *strongly agree* increased from 95% to 100%, while the increase was similar for unplanned transportation needs (84% to 100%).

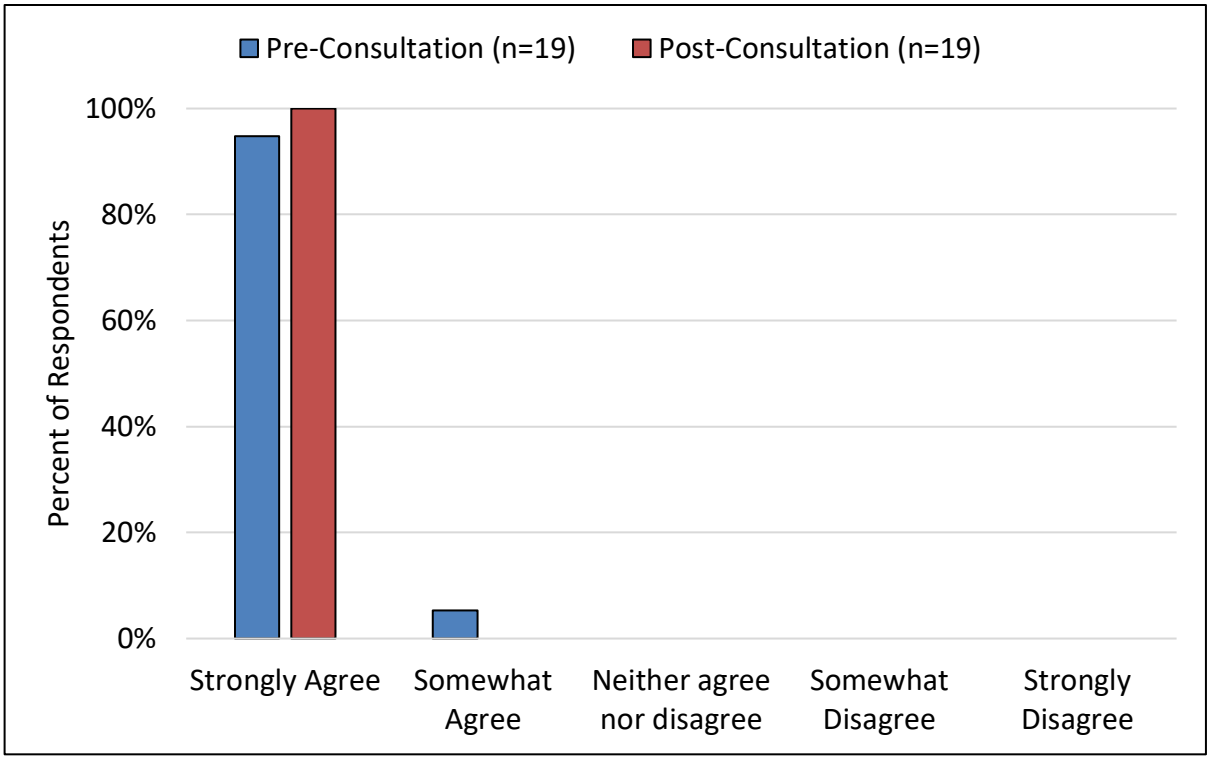

Figure 21. Survey item assessing planned transportation needs.

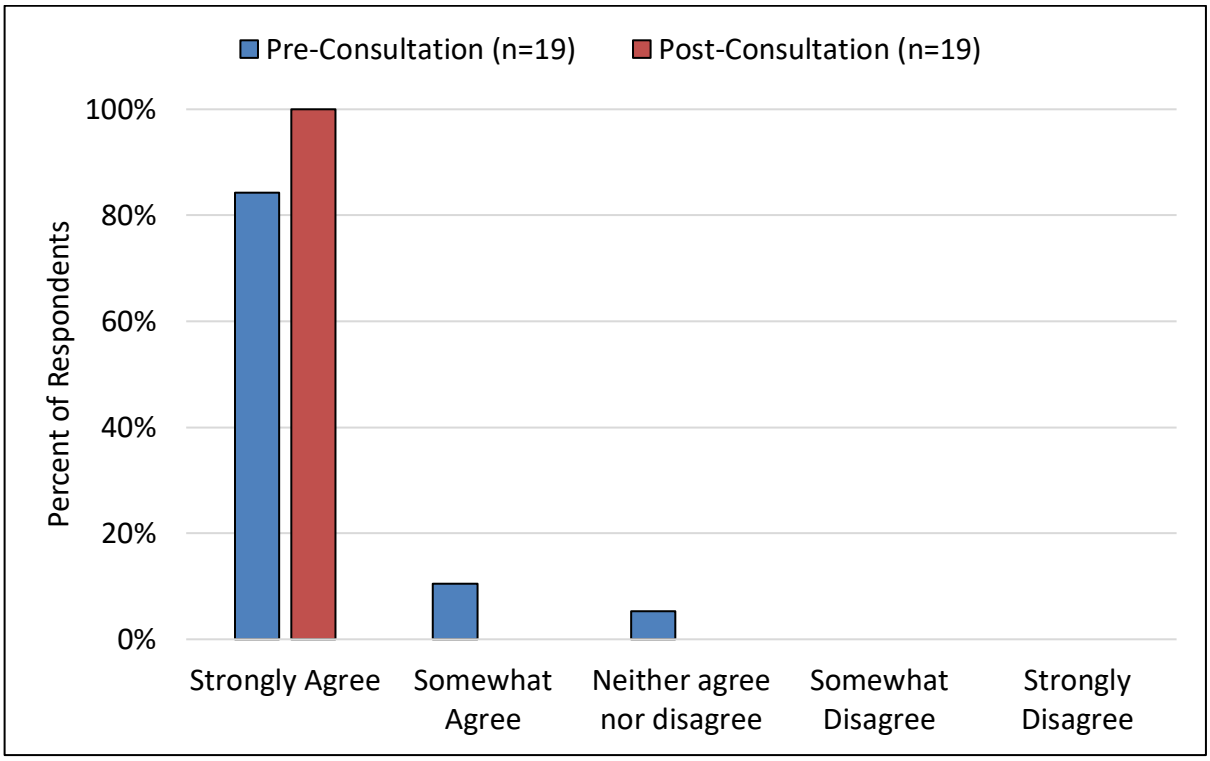

Figure 22. Survey item assessing unplanned transportation needs.

Participants' level of agreement about their reliance on others for transportation needs was also evaluated. The percentage of participants denoting they *strongly disagree* with the statement that they frequently have to rely on others increased from 68% to 79% (Figure 23).

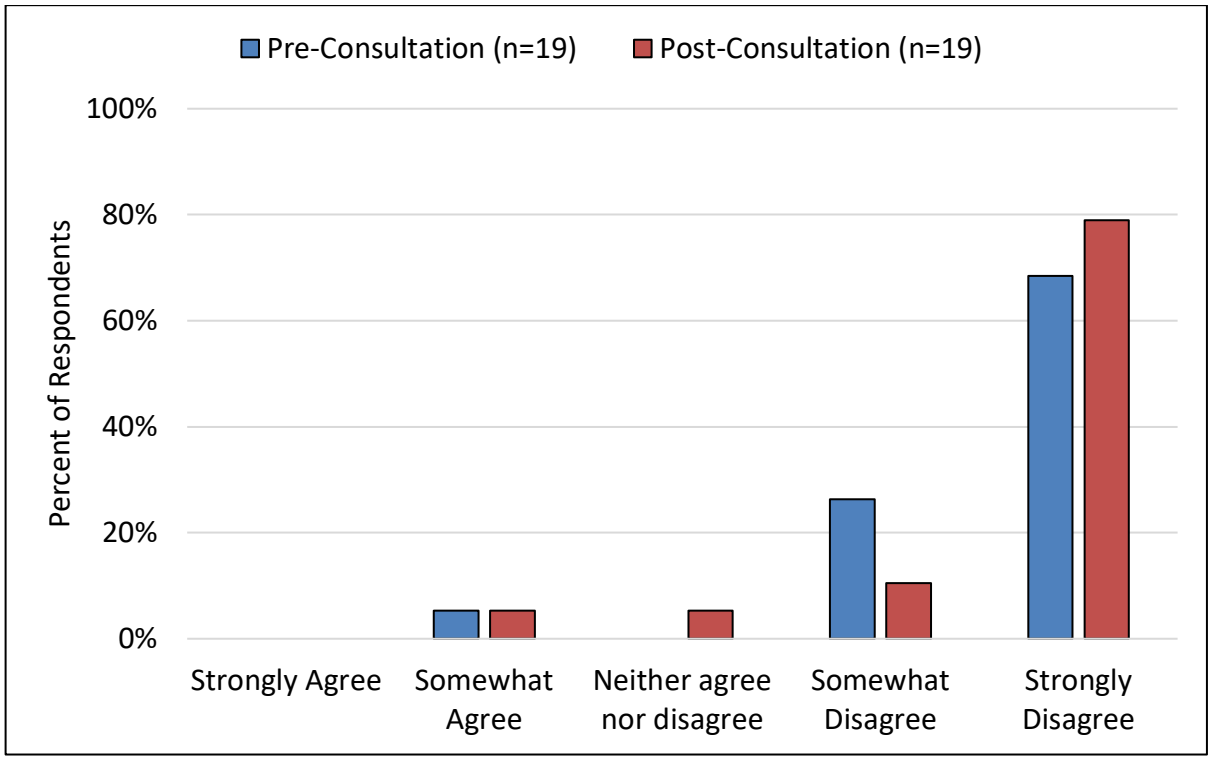

Figure 23. Survey item assessing reliance on others for transportation needs.

Participants showed a positive response to the statement regarding their overall sense of well-being has improved because of this program, with 42% indicating they *strongly agree* and 47% indicating *somewhat agree*. Participants unequivocally noted the strong desire (76%) to continue with the program if it were to be made available. Additionally, 79% of participants *strongly agreed* they would recommend the program to others.

We recorded participants' feelings regarding the degree to which the program was perceived as worthwhile. Responses were overwhelmingly positive, with 84% stating they *strongly agree* it was worthwhile and 16% stating they *somewhat agree*. Another survey item asked participants to rate their agreement that the mobility consultation made them feel safer and/or more confident about their driving. A majority (60%) of respondents indicated they *strongly agreed* with the statement, with another 27% indicating *somewhat agree*.

Finally, two additional items assessed the importance of the hands-on and personal touch aspects of the program, as well as the impact of tailored suggestions on program success. In both cases, participants *strongly agreed* (73%) that the personal touch was important and 80% that the tailored and personalized aspect was important to program success.

Exit Interview

All participants engaged in a semi-structured exit interview in which several aspects of the study were discussed. Common themes emerged and are shown below.[1]

- **How did you find the assessment process? (*n*=19)**
  - 100% did not find the assessment process burdensome or unduly time-consuming.
- **Did you seek out a stakeholder or another individual to help or support you through this program? (*n*=19)**
  - 84% did not feel the need for additional support beyond the knowledge that the research staff made available if requested.
  - 16% sought support from their spouse or family members.
- **In general, did you feel like your transportation mobility increased or improved after program implementation? (*n*=19)**
  - 21% felt they had increased mobility.
  - 79% did not feel their transportation mobility increased, though an additional 13% stated they feel they have safer mobility.
- **In general, how much did your driving habits change after program implementation? (*n*=19)**
  - 95% noted one or more changes in driving habits.
  - 5% did not note a change in driving habits.
- **Did participation in this program increase your awareness of your car's safety features? (*n*=19)**
  - 89% stated that consultation increased awareness of vehicle safety features.
  - 11% stated no increased awareness of vehicle safety features.
- **In general, did you feel more confident driving after program implementation? (*n*=4)**
  - 30% noted increased confidence following the consultation.
  - 10% noted an initial decrease in confidence following the consultation but with a slow return after a few days.
- **In general, did you feel safer driving after program implementation? (*n*=4)**
  - 100% stated they felt safer driving following the consultation.

A single Likert-style question was posed to assess participants' perceived value of the program based on their time commitment. A large majority (84%) stated they *strongly agreed* the program was worth the allotted time for the benefits received while the remaining 16% noted *somewhat agree*.

Participant Comments

Nearly every participant provided the researchers with unsolicited compliments and praise for the program. Table 5 presents a sample of such positive comments. Table 6 presents a sample of the relatively few neutral or negative comments.

[1] Note that the number of samples per question varies as items were modified or removed from the interview during the course of program enhancement.

Table 5. Positive Participant Comments

- I love it!
- This is just what I needed
- This has been so much fun
- It was helpful to realize where my weaknesses are so that I can work on them
- This is a great idea
- Very helpful
- This is great!
- I got a lot out of our conversation today
- It was like I was in a tunnel before, but now I can see
- This was so much more than just going through the motions – the researchers really cared
- Laying out all the issues is great for discussion
- This opens eyes and creates discussion points
- Helped a whole lot in daily life and activities – gave me confidence to get out and drive
- Helped get me back to basics for safety
- Everybody over 30 needs to do this program periodically
- It's been a real eye-opener
- I'm more aware of the mistakes I make and the things I need to fix
- This is a game-changer
- I have nothing but great things to say about the program
- I love what you've done here
- I really enjoyed this
- I shared with my friends they should look into the program
- I like anything that can help me…and it did!
- It gave me a different perspective on my driving habits
- Very in-depth
- This should be in driver's education classes
- Why didn't I think of that?
- I'm glad to have things to work on
- This has been very informative
- This is like a booster shot for driving safety
- It's been a very positive experience
- I was so impressed with the mirror and camera demo
- I really enjoyed the program – gave me a lot more confidence
- Provides information for future issues as well
- Very appreciative – makes me feel like I'm giving back. I love that.
- Did everything you could to keep me comfortable
- You listen and care
- I really liked the personal contact
- Made me aware of everything I was doing and how I can better/more safely get from point A to B
- It's been a very good thing
- This study has done a lot to make me more aware of my driving
- Wonderful idea
- You've really helped me
- I endorse everything you're saying
- It made me realize to slow down and be more aware of what I need to be a safer driver
- I really like your recommendations
- I'd do this without the money
- This type of individualized program could benefit so many older drivers

Table 6. Neutral and Negative Participant Comments

• I was hoping to have more discussion about specific scenarios and what to do • This information wasn't helpful to me now, but may be in the future • I was hoping to have more follow-up conversations	• The installation of the hardware took too long • I was very aware of the cameras in my vehicle • Would have liked to have assistance in verifying that I set my car up correctly (CarFit)
• I didn't like hard braking as part of the rating – what if I needed to?	• I didn't like the app – it was hard to remember to mark trips as passenger

DISCUSSION

In summary, a total of 19 participants engaged in this pilot program, which collected survey data alongside driving data. These sources were fed through a custom algorithm to determine potential discussion points during a mobility consultation session.

Program

Reception

A key aspect of any public-facing program is how it is received by the intended audience. Regardless of how valuable the information is, if those receiving the information are not receptive to it, the program will likely not reach its full potential. A summary of results from the exit survey speaks very highly of the program's reception among participants. When collapsed across those that either marked *strongly agree* or *somewhat agree* to key exit interview questions, the following become apparent:

- 89% reported well-being has increased as a result of the program;
- 100% reported the program was worthwhile;
- 100% would like to continue with the program if available;
- 89% would recommend the program to others;
- 87% felt mobility consultation made them feel safer or more confident about their driving.

These points touch on an important finding. Older drivers recognized the need for continuing driver education, felt that the program directly related to their overall well-being and recognized the value not only for themselves but for how it might positively impact others as well. These results are likely a function of three important program facets: (1) recommendations were based on each driver's unique condition and situation; (2) recommendations included practical, actionable steps; and (3) the program was administered by researchers at a major, local transportation institute, which lent authority and resonance to the information.

Aside from the tailored suggestions provided during the consultation session, it is also possible that some of the benefits come from simply spending time with another individual. Approximately 19% to 29% of older adults in the United States suffer from loneliness (Ong, Uchino, & Wethington, 2016). Dedicated time with these individuals may contribute to their overall sense of improved well-being. These findings heavily suggest that the in-person interaction with participants, alongside demonstrations and discussions is a key element, especially when the information provided is individualized rather than general. Future iterations should strive to maintain personal interaction and attention, to the extent possible, as well as continue to provide elements tailored to the individual.

Additionally, some participants provided unsolicited comments throughout the process that alluded to prior attempts at family members changing driving behaviors. In this case, the participants dismissed the prior information they received (typically from a spouse) and noted that they had greater trust in the information provided by trained and experienced research staff (Blass and Schmitt, 2001; Burger, 2009; Milgram, 1963).

Program Presentation

Another finding from the exit survey relates to the structure and presentation of information. For this effort, the researchers created a program with tailored information that was focused on hands-on interaction with older drivers. Exit survey results show our effort was successful, with the vast majority (93%) saying they *strongly agree* or *somewhat agree* that both the hands-on and tailored aspects of the program were important to them. In general, these findings match with previous work showing that tailored training for participants showed positive effects on driver safety outcomes (Anstey, et al., 2018; Ashman, Bishu, Foster, and McCoy, 1994; Owsley et al., 2004). In each of these cases, tailored training produced positive safety outcomes with older adults and further highlighted the importance of personalized training.

Interventions

During the exit interview for Phase 1, feedback was solicited for specific interventions. In general, all interventions or discussions were viewed positively. Participants were actively engaged in the conversations and often volunteered additional information for consideration. The interventions that had more immediately visible results tended to spark feedback. For example, the CarFit sessions and demonstrations such as backup camera training were often met with surprise at how helpful the changes were. During CarFit sessions, participants often noted dramatically increased visibility or a reduction in pain associated with a changed seating position. In one case, a participant noted reduced pain in her feet and shoulder from the altered seating position. Another common finding in the CarFit session involved extraneous objects near the pedals (e.g., extra floor mats or purse).

Interventions that consisted of a demonstration of some sort, such as the backup camera training, CarFit mirror adjustments, and phone pairing also appeared to be important. The backup camera session often provided participants with a dramatic recalibration of the blind spot directly behind their vehicle. The demonstration of this blind spot using a “hidden” object (i.e., a strategically placed traffic cone in this case) was paramount in conveying the importance of glances to the camera screen. Similarly, with the mirror adjustments during CarFit, the demonstration of visibility in the side mirrors (by walking parallel to the vehicle) highlighted the change. Finally, for participants that had difficulty pairing their phone with their vehicle (whether Bluetooth or Android Auto/Apple CarPlay), the researcher walked them through pairing and use of the technology. The act of demonstration appeared to be important. In all three cases, these interventions produced an immediate effect and likely had a more profound impact because of it.

A second common theme surrounded basic safety. In some cases, participants had expressed views that the program was similar to a booster shot or that it helped bring them back to the basics of safety. In all cases, our participants had been driving for at least 45 years. Many of the safety-related behaviors noted during driving assessment were fundamental in nature. Typical findings included not completing a full stop at stop signs, not signaling or performing an over-the-shoulder glance prior to lane changes, not using a backup camera (if present), secondary task engagement, or slightly aggressive braking and

cornering maneuvers. Over time, bad habits may form, especially if no negative outcomes result from the behaviors in question; this program helped to reaffirm the importance of safe driving practices. At the onset of the program, a wide range of potential interventions were selected. After the first 10 participants, it became clear that only a subset was utilized frequently. In this effort, only eight interventions were used with 30% or more of participants; these focused on alternate routes, backup cameras, secondary task engagement, phone connectivity, health care providers, seat belt use, neuropathy, and in-vehicle technology. Alternative routing was one of the most presented interventions but was not universally useful. For three participants, the proposed alternative was already known or was too inaccessible for frequent use. This is likely partially due to the rural nature of the study location. In many cases, only a few alternative routes are available, and therefore it is likely the participant is already aware of them. However, in more-populated areas where the number of alternative routes increases, reception may be better. Of the two who were unaware of the alternative routes suggested, the reception was positive, with one participant stating he was “elated” to be made aware of the alternative.

While these are the more common interventions, it does not necessarily indicate that those used less frequently are any less important. For example, with one participant, a single survey item indicated potential hearing loss. Following up with that probe revealed not only significant hearing loss but a profound impact on his well-being in a number of both driving and interpersonal dimensions. The discussion illuminated the safety impact of hearing loss on situational awareness and the resulting vulnerability, stress, and anxiety it caused the participant. The participant began to understand how his hearing loss was at the center of several emotions. When combined with his known interpersonal struggles, the discussion had a profound impact on him. Additionally, another participant’s vehicle was equipped with Android Auto functionality, but she was unaware of that. She often held her phone on her lap while using navigation. Researchers were able to show her how to connect her phone, not only for hands-free calling functionality but also for navigation integration. This was a participant who purchased a model year 2019 vehicle and was not shown how to use basic functionality. Her response after the training was one of elation—she was amazed that integration technology existed, let alone that she had access to it in her vehicle.

Changing Vehicle Fleet

In this effort, only two vehicles were equipped with Level 2 ADAS. As the fleet continues to turn over, the number of older drivers with these systems will only increase. As was evidenced by the number of participants who struggled with either phone-vehicle connectivity or with correct use of the backup camera, proper training is needed to utilize these safety systems. As vehicles become more complicated, the number of opportunities for training will grow dramatically and, if drivers are not using them correctly (or at all), the intended safety benefits will not be realized. Future iterations should focus on developing training materials to aid in advancing education on Level 2 or Level 3 systems already in the market, as well as new technologies as they become available.

Similarly, some participants in this effort highlighted a similar gap between technology availability and technology utilization. In one case, a participant had Apple CarPlay and Android Auto capabilities but was not ever trained on the system. Another had the ability to connect to her infotainment system for navigation and call purposes but chose to avoid doing so due to the costs associated with a proprietary service. Simply having safety-related equipment present does not necessarily mean drivers will use or know how to use it. For those vehicles newly entering the fleet, phone connectivity has become

ubiquitous, with over 98% of model year 2023 vehicles including either Android Auto or Apple CarPlay (“Infotainment Takeover,” 2023). It is possible that phone connectivity will need to continue to be a focus area until drivers aging into this age group are much more fundamentally comfortable with technology.

The suggestions we presented to participants did not constitute a requirement to remain in the study. They were free to engage with our solutions at their discretion. As a result, some items were likely not acted on. For example, in one case, researchers engaged in a discussion related to eating (in this case, a burger and container of nuts) while driving. However, the driver chose to continue to eat because he believed it would stave off drowsiness, and the risk from doing so was lower than the risk he would assume if he became drowsy. Similarly, another driver continued to floss his teeth while driving as he did not believe it increased his risk in any appreciable way. Finally, findings from the ORD discussions showed a minor, though likely insignificant increase in drowsiness (future work with a larger number of participants should explore this). Thus, recommendations may not always be implemented.

Degree of Impairment

Participants responded with overwhelming positivity to the program, yet not all found the benefits currently applicable. This suggests that the degree of driving (or generalized) impairment may be related to the program’s perceived level of benefit. Participants who are relatively healthy may not see the value of certain of the recommendations. On the other hand, participants who are so impaired that they may not be capable of benefitting from the recommendations may not perceive much value either. In some cases, these drivers may simply have been less open to changing those behaviors. For example, one participant consciously chose to continue eating while driving because he used it to stave off drowsiness. As a result, his findings showed an *increase* in secondary task engagement.

Additionally, another participant showed no change in merely slowing at stop-sign controlled intersections because she felt the risk was low and she could see well enough without stopping. Conceptually, the ideal participant characteristics required for an optimal intervention are displayed in Figure 24. Note that many self-selecting behaviors may prevent those who need help from seeking it out.

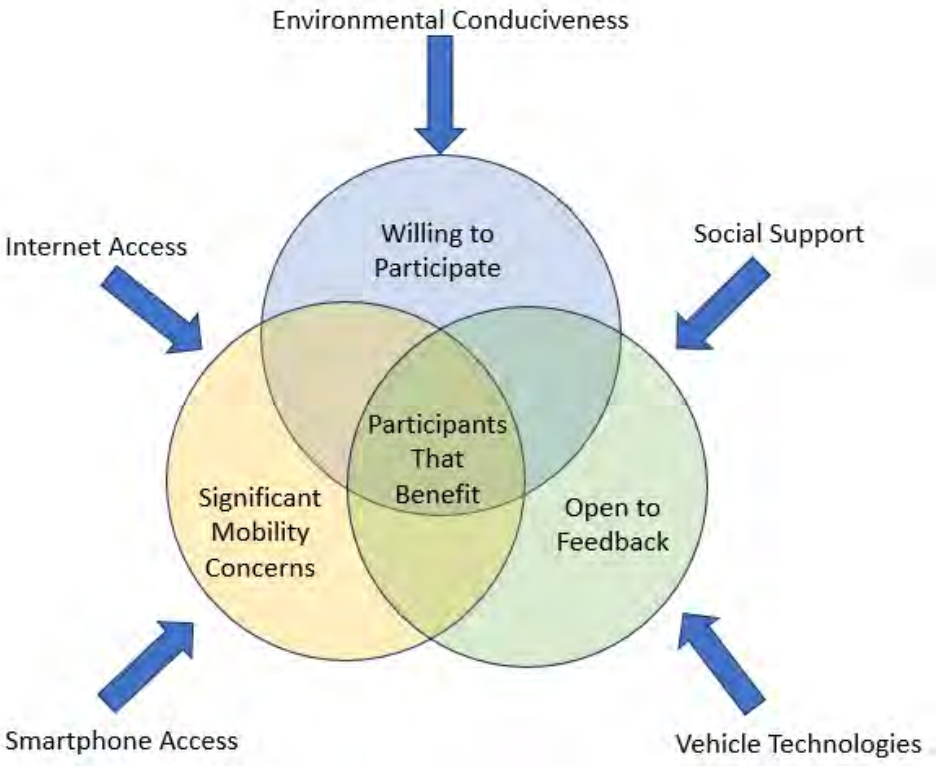

Figure 24. Conceptual Venn diagram showing characteristics needed for successful intervention.

It is worth highlighting, though, that all participants felt the information presented was worth the time commitment required by the program. This suggests that even those with high levels of independence still found value in the program, which can be interpreted in one of two ways: (1) the program applies to the vast majority of older drivers to some degree, and (2) while the information may be helpful to all, a focus should be on those with a level of impediment that is great enough to support intervention but not too great as to make intervention overly difficult to employ.

Methodology Comparison

At the outset, this program utilized the NDS paradigm as an important component of both (1) evaluating participants' driving behaviors in order to formulate individualized recommendations and (2) determining the degree to which those recommendations made an impact on participants' driving safety post-consultation. However, this approach is relatively costly; extremely technician, analyst, and researcher time-intensive; and, to a great extent, geographically limited to those living in the vicinity of VTTI. So, with our goal of expanding the program's footprint to a broader audience, we explored methods that would facilitate program expansion while retaining the program's positive impact. The following is a discussion of the benefits and limitations of the methods deployed during the study period.

NDS Driver Evaluation

Benefits

The NDS approach to driver evaluation provided a tremendously rich dataset that allowed analysts to record and code behaviors, environmental context, glance locations, and seat belt use. This video-based data collection also allowed analysts to note ad hoc behaviors such as repeated pulling to the side of the road, backing along a roadway to enter a driveway, or stopping in the oncoming lane to

check mail. Such behaviors were not envisioned at the outset, but being able to observe these became important in evaluating participants' driving safety and mobility ecosystem. The utilization of the DAS also allowed stepping through the video data in slow motion to extract all relevant information without the time pressure of coding in real time. Such control was important when evaluating glance behaviors or drowsiness.

Limitations and Solutions

Working with a large, complex dataset is non-trivial. Along with the flexibility of a custom installation and a variety of disparate data to analyze comes additional complexity, time, and cost. Not only did the data require several steps of processing before showing up in the database, but the development of analysis protocols, sampling plans, and time requirements to sift through large amounts of naturalistic data prevented a quick turnaround for consultation purposes. Additionally, the cost associated with the development, physical installation, and deinstallation of the DAS precludes it from being feasible in larger-scale efforts, without a concomitant substantial increase in funding.

Also, due to time lag time in the DAS bootup, many backing or seat belt use behaviors or events at the start of trips were not captured. This prevented the researchers from either (a) evaluating these behaviors as material for the consultation session (unless volunteered by the participant) or (b) evaluating any sort of pre- and post-consultation behavior changes. Together, the richness of the data from the VTTI DAS comes at a cost and would be best used in situations where highly detailed data are paramount and turnaround time is of less importance.

Test Route Driver Evaluation

Benefits

Like the NDS approach, using a standardized test route allowed for eyes-on evaluation of real-world driving, but without the large overhead of data processing and analysis. The presence of the two researchers during the test route also afforded the opportunity to identify additional safety concerns. Some examples include apparent hesitancy or anxiety during merging maneuvers or even potential misunderstandings of vehicle safety systems. Another large benefit of the predefined test route was the dramatic reduction in the time taken to collect, process, and analyze the data. With our implementation of the NDS approach, we recorded participants for 2 months prior to the relatively time-consuming data processing and analysis phases. In comparison, the standardized route required approximately an hour and a half of time for data collection, processing, and analysis. This method would be best utilized in efforts where a quick evaluation of driver behavior was required and highly detailed information is of slightly less importance.

Limitations and Solutions

One limitation was the time commitment required to collect this data. While less than the NDS collection, the half-hour route required two researchers and was completed for three iterations, resulting in approximately 3 hours of collection (for two researchers) and an hour for discussion and data entry per participant. The process was initially designed such that only one researcher was required to complete the test route with participants, but pilot testing showed that to not be feasible.

Due to the requirement for two researchers on each drive, several team members were required to be trained on the protocol for flexibility. Increasing flexibility had the unintended consequence of slightly different scoring tendencies, even in the presence of a rubric. To reduce this impact, following each session, researchers would discuss their notes. Secondly, multiple researchers also created situations

where those present during the first drive were not necessarily the same present during subsequent drives.

Determining a single overall rating for each rated driving behavior or element across the entire test route proved unwieldy. To address this, ratings were provided for identified route segments. However, even within a segment, multiple iterations may be present for a given item (e.g., stop signs or intersections). Unfortunately, this required the researcher to mentally track behavior and apply an *overall* score across iterations. The team attempted to reduce the cognitive overhead by utilizing a *demerit* column where tic marks could be used to track infractions within a scoring item. While this helped to minimize the overhead required within a segment, it did not alleviate it completely. One alternative would be to focus on a few key items in each segment that are more dangerous. For example, focusing on lane change and merging behaviors during the highway segments and on situational awareness and traffic control device attention in the residential areas. Doing so would drastically reduce the time allocated to less severe behaviors while still allowing a focus on key items as well as any other notable behavior during the drive.

The most significant limitation of the test route was the lack of data. In Phase 1, the researchers had a month of driving data to evaluate compared to 30 minutes in this effort. The obvious drawbacks include the inability to view rare events that might be present in 2 months of naturalistic driving, as well as the relative inability to determine the prevalence of more common ones. For example, on the test route, the participant may have failed to come to a complete stop at two of the stop sign-controlled intersections, but naturalistic data may have shown this to be a relatively rare event.

Finally, the presence of researchers may have affected the participant's driving, whether that was expressed through a purposeful hiding of unsafe behaviors or the obverse, increased performance anxiety resulting in more unsafe behaviors.

Smartphone App-Based Driver Evaluation

Benefits

The smartphone app further reduced researcher overhead in terms of both data collection and data processing. Data collection only required a few minutes to install the app. Similarly, data processing now only required data download and converting the presence of events into a rate for interpretation. Additionally, with the use of a smartphone app for data collection, the number of potential participants that could be included while still incorporating a modestly staffed research team is greatly expanded. Not only has the time commitment required for data collection setup been reduced from hours to minutes, but those minutes also do not require researcher presence.

Another large benefit of the smartphone app is the built-in data processing it affords. Whereas data from a VTTI DAS requires significant processing before it can even be viewed, much less analyzed, data from the app is nearly instantly viewable on its portal. This method would be best utilized in very large-scale efforts where the management of large quantities of data is required and highly detailed information is not as important. In such a scenario, the app data portal (and subsequent processing) would prove invaluable to organize and store data.

Limitations and Solutions

Several limitations exist when relying on data from any third-party data collection apparatus (i.e., the smartphone app used in this effort). First, the star ratings assigned to drives lacked context. Not only

was a rating applied to the entire drive without specific geotagging or time stamps illustrating which moments or behaviors led to the issuing of that specific score, but VTTI researchers did not have access to the proprietary algorithm that assigned ratings. Thus, the specific conditions in which four stars would be assigned vs. three remains opaque.

Another limitation resulting from the use of the smartphone app is the narrow selection of data recorded. For example, the current iteration only allowed for the collection of assigned star ratings along several dimensions. The app allows for the provision of kinematic event data, but it was not available within the time frame required for this effort. Kinematic data, including hard braking and hard cornering, could provide important additional information to aid in understanding the star rating system. Finally, other important driving behaviors are not feasible or possible to collect on smartphones apps (unless there is a camera incorporated in some fashion) such as glance locations during lane changes or backing maneuvers, secondary task engagement (other than phone), and drowsiness. In many cases, these additional behavioral metrics may be *more* important than kinematic data but are unavailable.

Overall Program Limitations

While we did not see evidence of this in these pilot iterations of the program, it is possible that participants may gain a false sense of confidence, which may lead to increased risk. The hope is that by providing the consultation session, researchers were able to point out areas of weakness and initiate the process for improvement. This *should* help to improve safety and confidence and therefore improve mobility; however, *increased* mobility may not always be a good thing. An unsafe driver with greater mobility is increasing their (and other road users) risk due to increased exposure.

Next Steps

Following the conclusion of Phase 2, it is clear that the ROAD TRIP program provides value to older adults and that to reach a larger number of drivers, the program must be modified. One such example may be to convert the current researcher-driven analysis process, currently completed in Excel, into a software program. This would minimize human error and effort, as well as allow for the easy expansion of that facet. Additionally, several of the interventions could be reworked to make them more standardized and modular; that is, they could be molded into a process by which, as certain suggestions are triggered by our algorithm, links are generated to video content discussing the concern. Like the above, this would greatly allow for the expansion and modularization of the program. Following this process, a partnership and integration with national organizations such as AARP and insurance (both health and car) companies could pave the way for wide dissemination.

GENERAL CONCLUSION

The ROAD TRIP program highlighted the fact that older adults, specifically in rural localities, can benefit from personalized recommendations to improve their driving safety and mobility, and they overwhelmingly appreciate such a program. As discussed above there is a direct link between the degree of program complexity and its ability to effect change on a large scale. To this end, the research team continues to look for ways to maximize the program's footprint while maintaining its impact and the overwhelmingly positive way it is received.

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APPENDIX

APPENDIX A – CONSENT FORM

Title of research study: ROAD TRIP (Recommending Options for Aging Drivers- Tailored Research-Integrated Plan) – Phase 2

Principal Investigator: Jonathan F. Antin, Ph.D., CHFP, jantin@vt.edu, 540-315-1086

Primary Contact: ***Brian Wotring (bwotring@vtti.vt.edu; 540-315-1086***

Key Information: The following is a short summary of this study to help you decide whether you would like to participate in this study. More detailed information is included below this summary.

Why am I being invited to take part in a research study?
You are over 65 years old and have problems accessing goods and services due to transportation difficulties or limitations.
What should I know about being in a research study?
Someone will explain this research study to you.
Participation is optional. If you decide to take part, you are always free to change your mind and exit the study at any point without penalty.
Your vehicle will be instrumented with sensors and cameras. The cameras will take video of your face, the forward roadway and up to two additional views described in this form. No audio will be collected.
The video and other data that tell who you are, or could be used to tell who you are, will be held under a high level of security. Your data will be linked with a code rather than your name.
We will do our best to not collect identifying video information on passengers in the vehicle; however, passengers sitting right behind the driver will be the most vulnerable to being seen on video.
Only qualified researchers will be allowed to have access to data that could be used to identify you. The level to which they have access will be based on their level of authorization.
You are welcome to ask all the questions you want before you decide.

Why is this research being done?
The purpose is to study how a personalized driving plan can enhance driving safety and increase mobility for drivers aged 65 and older who report problems accessing goods and services due to transportation difficulties or limitations.

How long will the research last?
Participation in this study will last up to 3 months.
What will I need to do if I choose to participate?
If you choose to participate, you will need to do the following:
Meet with a researcher who will review the consent form and answer any questions you have. The researcher will help you enroll in the study.
Complete a set of intake assessments.
A technician will install equipment with cameras and sensors in your vehicle. We will provide additional details about the equipment later in this form.
Drive the instrumented vehicle for 3 months.
During the first two weeks, you will drive as you normally would.
During the second month, we will meet with you to review data from your first two weeks and to present an individualized plan that includes measures designed to enhance your mobility and promote driving safety.
During the third month, we will encourage you to incorporate these measures into your driving.

At the end of your participation, meet with a researcher so that the equipment can be removed from your vehicle, complete a brief survey, and talk with a researcher about your experience in the study. A researcher can come to your home for all study appointments, or study appointments can occur at another suitable location convenient to you. You may also choose to have a friend or family member or a VTTI researcher drive your vehicle to VTTI for vehicle-related appointments and return it to you once those appointments are completed.

Is there any way being in this study could be bad for me?
The operation or drivability of the vehicle should not be affected by the instrumentation, and thus carries a similar risk as when you operate any vehicle normally. However, if you violate state or local driving laws, the instrumentation could record evidence of these violations. A variety of strategies are in place to reduce the potential of legal harm in these cases.

More detailed information about the risks of this study can be found under ***"Is there any way being in this study could be bad for me? (Detailed Risks)"*** **on page 11.**
Will being in this study help me in any way?
The study does not have any guaranteed benefits. However, you will be given an individualized mobility plan that includes suggestions and resources that may make you aware of safer driving practices and extend your mobility, as well as improve your access to goods and services.
What happens if I do not want to be in this research?
Taking part in research is completely up to you. You can decide to participate or not to participate.
Detailed Information: The following is more detailed information about this study in addition to the information listed above.
How many people will be studied?
We plan to include about 15 people in this study.
What happens if I say yes, I want to be in this research (Detailed Study Procedures)?

Steps involved in Enrollment

Consent and Study Intake

Consent and study intake can occur at your home or another suitable location convenient to you.
You will receive pictures of both the researcher and the technician prior to the day of the appointment.
First, the researcher will confirm your eligibility to participate by asking you to present a valid U.S. Driver's License and proof of liability insurance.
The researcher will then review this form with you and answer any questions you might have.
You will then sign the consent form. A copy of the signed form will be provided to you.
The researcher will capture an image of you with a digital camera for driver identification purposes.
Once you sign the consent form, you will complete a W-9 form for compensation purposes.

Intake Assessments

As part of your intake session, you will complete nine surveys and assessments. Researchers use these instruments to collect data about your health and physical fitness, grip strength, reaction time, contrast sensitivity, flexibility, balance, driving knowledge and behaviors, and your driving preferences and level of accessibility.
The consent and study intake session should take no more than two hours.

Vehicle Instrumentation:

The technician will complete and review a checklist with you to document the condition of your vehicle before the study equipment is installed. The technician will complete this form before and

after installing the study equipment in your vehicle. The researcher will review this form with you and ask you to sign it. A copy of the signed form will be provided to you.
You may choose to have a friend or family member or a VTTI researcher drive your vehicle to VTTI for instrumentation and return it to you once instrumentation is complete.
Allow the technician to install data collection equipment with cameras and sensors in your vehicle. The technician will show you where we will place the system and show you pictures of what the completed installation will look like.
Installing the equipment should take up to 2 hours.
The technician will need to access the glove box as part of this installation.
The technician will need to use the front seat area of your vehicle to complete the installation.
The technician may need to drive your vehicle briefly during the installation and testing process.

Driving Period (3 months):
Pre-Consultation Period
Drive as you normally would for the first month of the driving period. We ask that you not drive the vehicle into any areas where cameras are not allowed, including any international border crossings, military bases, or similar facilities.
A researcher will collect driving data from the vehicle after the first month. This activity can occur at your home or another location convenient to you. You may choose to have a friend or family member or a VTTI researcher drive your vehicle to VTTI for the drive replacement and return it to you once that is complete.

Driving Consultation
During the second month of your driving period, a researcher will meet with you to present a plan designed to enhance your mobility and driving safety. This meeting can occur at your home or another suitable location convenient to you.
During this visit, we will discuss the results of the assessments you completed at intake and our analysis of data collected from your first month of driving. A plan will be tailored just for you. This plan will include strategies designed to increase your mobility and drive more safely.
During this session, we will swap the data drive.
This meeting should take no more than two hours.
Post-Driving Consultation Period
During the month following the driving consultation, we will ask you to drive according to the plan presented to you during the driving consultation.
Throughout the Driving Period
Tell other drivers of the vehicle about the equipment installed in the vehicle. Advise other drivers of the video equipment installed on the vehicle and ask them not to drive into areas where cameras are not allowed. Let these other drivers know that data will be collected when they drive but will not be analyzed.
Respond to occasional requests for study equipment maintenance or additional data drive swap replacements. It may be necessary for us to perform equipment maintenance or an additional data drive removal and replacement. This may occur up to three times during your enrollment. These activities can occur at your home or another suitable location convenient to you. Compensation for these additional activities is explained later in this form.
If you are in a crash, we ask that you let the research team know about the incident at your earliest convenience once you and your family are safe.
Find a safe place to pull the vehicle over.

Seek emergency help, if necessary, the way that you normally would.
Please let the research team know about the incident at your earliest convenience.

Study Equipment Removal and Study Exit
Meet with a researcher so that the equipment can be removed from your vehicle. This activity can occur at your home or another location convenient to you. At that appointment, the researcher will complete and ask you to sign the same vehicle condition checklist that was used when the equipment was installed before and after removing the equipment. The researcher will provide a copy of this form to you.
You may choose to have a friend or family member or a VTTI researcher drive your vehicle to VTTI for study equipment removal and return it to you once removal is complete.
You will complete a survey and talk with a researcher about your experience following the plan we presented to you during the driving consultation.
This appointment should last no more than 4 hours**.**
What happens if I enroll in the study, but I change my mind later?
You can leave the research at any time, for any reason, and it will not be held against you.
If you decide to leave the research, contact Brian Wotring at 540-315-1086 or bwotring@vtti.vt.edu so he can schedule a time to remove the study equipment from your vehicle.
Should you choose to leave the research, we will not analyze any of the data collected after you tell us you want to leave. However, we will analyze data collected prior to that point.
Data Collection
The next section describes the data and information to be collected as part of this research. It explains how the data will be collected and how the data will be stored and used in the future.
Data will be collected to be analyzed in future research efforts. Information is collected about you, where necessary. Both are stored securely and used as described below.

INFORMATION
Contact information includes your name, address, email address, phone numbers, and similar information used to contact you when needed. It will be stored securely in electronic form at VTTI during the study and destroyed one year after the study is complete (unless you grant permission for us to keep your contact information when the study is over). This information will not be linked to or mingled with your study data and will not be used in any research or analysis.

Auxiliary study information includes your Social Security Number and similar information. This information is used to compensate you for your participation. Auxiliary study information will be stored securely and destroyed after the study is complete. This information will not be linked to or mingled with your study data and will not be used in any research or analysis.

DATA (Used for Research)
Driver data includes the image of your face we obtain at consent, your responses to surveys administered at intake, and data collected using the assessment instruments. Additionally, researchers will record the location of the driving consultation meeting, the relationships to you of any people who are present during or attend the meeting with you, and concerns expressed by your or the researcher during the meeting. These data will not contain your name or any identifying information and will be used in analyses, both on their own and in combination with the driving data and vehicle data and data collected using the SAGE assessment administered during Phase 1 of this study. These data will be stored securely in electronic form indefinitely.

Driving data includes the data we collect from your vehicle while you are driving, including video data and sensor data. These data will contain video of your face and GPS coordinates of your trips, and either or both could be used to personally identify you. These data will be stored securely in electronic form indefinitely.

Vehicle data includes your vehicle year, make and model, its condition, and how it is equipped. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data and driving data. The VIN number is also considered vehicle data and allows researchers to confirm the year, make and model of your vehicle. It will be used for pre-installation preparations only. These data will be stored securely in electronic form indefinitely. VIN data collected at time of screening will only be kept if you decide to provide written consent and participate in the study.

How Data and Information are Collected

A small Data Acquisition System (DAS) containing cameras and sensors will be attached to the windshield and rearview mirror such that it does not interfere with your view of the forward roadway. All video will be captured and stored in digital format. Two cameras will record your face with some added space around the head to handle any head movements and the forward roadway. Up to two additional cameras will be installed to record other views, possibly including the rear roadway, the turn signal stalk, the dashboard and steering wheel, and/or the instrument panel. The views selected for your vehicle are indicated below:

Driver's face and forward roadway

Rear roadway

Turn signal stalk

Instrument panel

Dashboard and steering wheel 

What happens to the information and data collected for the research?
We will make every effort to limit the use and disclosure of your personal information only to people who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the Virginia Tech Human Research Protection Program, and other authorized representatives of Virginia Tech.
Any data collected during this study that personally identifies you or that could be used to personally identify you will be treated with confidentiality. As soon as you begin participating in this study, your name and other identifying information will be separated from the raw data collected while you drive the vehicle and replaced with a number. That is, your raw data will not be attached to your name, but rather to a number (for example, Driver 0011). The raw data collected while you drive the vehicle will be encrypted (made unreadable) from the moment it is collected until it is transferred a secure server at VTTI in Blacksburg, Virginia. Your name also will be separated from any data about you, either provided by you in response to the eligibility questionnaire or gathered by researchers during the study, and will be replaced by the same driver number (for example, Driver 0011).

During the data collection phase of this study, all data collected from the vehicle will be encrypted (made unreadable) from the time of its creation and then stored in a specific password-protected project folder on a secure server; the driving data will only be decrypted (made readable) once it has been stored in this folder.

We expect the data from this study to be useful for several years after the study is over. As such, we will plan to keep and use it indefinitely. It is expected that other researchers beyond the original study team identified in this form as well as industry partners may also find the data and results of this study useful. We will allow these individuals to use the data under the following conditions:

Data containing Personally Identifying Information (PII): These data contain information that could be used to personally identify you. Examples of PII are images of your face or the GPS coordinates of the beginning and ending of your trips. These data will be stored securely only on VTTI servers. VTTI study team members may access PII for the purposes of this study. External researchers wishing to use data containing PII for future research will be required to submit proof of prior IRB approval. These researchers will only be allowed access to temporarily view these data in a secure environment or in adherence with National Institutes of Health (NIH) guidelines. These external researchers will be required to sign a data use agreement assuring they will extend the same privacy protections to your PII that are outlined in this form.
De-Identified Data: We will separate your private information from data that are collected during this research; de-identified data (which cannot be associated with your identity) could be used for future

research studies or distributed to another investigator for future research studies without your additional informed consent.

a. VTTI researchers will have access to this data.

b. Researchers outside VTTI may use data that does not contain PII after they sign a data use agreement.

Additionally, project personnel and other qualified, authorized research partners may show specific clips of video to the study sponsor or at research conferences. Your name and other personally identifying information will never be associated with the showing of these video clips. Identifying location information will not be shared in association with these video clips.

You will not have access to your study data; we will not offer to share your data with you.

If you would like to view a specific segment of your study data to defend yourself in a criminal or traffic case, or for any other legal or financial matter, you should contact Brian Wotring at 540-315-1086.

Certificate of Confidentiality

Throughout the study, we will take all possible steps to protect your privacy and keep confidential your role in the study and the confidentiality of your personally identifying information. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, neither the researchers nor study sponsors can be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, this privacy protection does not prevent the researchers from disclosing voluntarily matters such as elder abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such habitually running red lights at high speed, repeatedly failing to keep the vehicle in the lane, or consistently traveling grossly over or under the speed limit. If this type of behavior is observed, we reserve the right to remove you from the study and inform the appropriate authorities.

Identifying information for the purposes of this study includes your contact information, your auxiliary study information, your driving data (including video of your face and GPS coordinates which may identify your home and places you frequently drive or any information in your driver data or driving data that could be used to personally identify you.

You should understand that a Certificate of Confidentiality does not prevent you or a member of your family from voluntarily releasing information about your involvement in this research. If you want your research information released to an insurer, medical care provider, or any other person not connected with the research, you must provide written consent to allow the researchers to release it.

The Certificate of Confidentiality does not mean that the Federal government endorses this study. The protections of the Certificate of Confidentiality described herein may not apply to passengers of the vehicle who have not consented to being in this study.

You, too, are responsible for taking steps to protect your privacy. Do not post or disclose your participation on any public forum, including websites, Facebook, newspapers, radio and television. Protect your role in the study the same way that you protect other personal and private information. If you do not keep confidential your role in the study, there is a risk that some of the data collected during the study, including your personally identifying information, may be used against you in a court case or other legal proceeding.

If you are involved in a crash while participating in this study, the data collection equipment in the study vehicle will likely capture the events leading up to the event. You are under NO LEGAL OBLIGATION to voluntarily mention the data collection equipment or your participation in this study

at the time of a crash or traffic offense. We have provided a letter which you should keep in a safe place in the vehicle, such as the glove box in case a law enforcement officer asks you about the equipment. The letter describes the vehicle's role in the study without identifying you as a participant in the study.

Is there any way being in this study could be bad for me? (Detailed Risks)

There are non-driving risks inherent in this study. The vehicle is equipped with cameras. If you drive into an area where cameras are not allowed, including international border crossings, certain military and intelligence locations, and certain manufacturing facilities, there is a risk that you may be detained or arrested or that the vehicle may be impounded.

Because the vehicle camera system is storing continuous video, it is likely that it may capture some incriminating evidence if an at-fault collision should occur. With the Certificate of Confidentiality, the researchers cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings.

Additionally, there is the risk that cameras may capture illegal activities such as elder or child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. As explained above if this type of behavior is observed we reserve the right to remove you from the study and report the behavior to the authorities.

If the owner of the car gives a VT employee permission to drive their vehicle, that employee could be involved in a crash, causing damage to the vehicle,

The following precautions will be taken to minimize the risk to you throughout your participation in the study:

General Steps Taken to Reduce Risk:

Scheduling activities to take place at your home or at a suitable location convenient to you or allowing a friend or family member or a VTTI researcher to drive the vehicle to VTTI for vehicle-related appointments then return it to you ensures that you are not asked to drive to new locations with which you may be unfamiliar and limits any required driving trips outside your normal driving. The researcher will make every effort to only enter the designated meeting space.

If you choose to have a researcher drive your vehicle to and from VTTI for any vehicle-related appointment, VTTI takes the following steps to reduce the risk of an accident or damage to your vehicle:

VTTI employees driving participant vehicles are experienced, licensed drivers.

VTTI employees are only allowed to drive the vehicle to VTTI and back to your home. No other stops are permitted.

A researcher will call you on the day before the scheduled intake appointment to confirm the appointment and address any questions any concerns you have about the study.

You will receive pictures of the researcher and technician who will meet with you before any study appointment.

Researchers and technicians will wear apparel that clearly establishes their affiliation with VTTI to all study appointments.

If others are present during or attend the driving consultation meeting with you, they may overhear the conversation and become aware of our recommendations to you.

If you become tired during the time the researcher administers the assessments to you, you are welcome to ask for a break at any time.

You are free to ask questions and to withdraw from the study at any time. You can decline to answer questions. Any paperwork containing information that identifies you (e.g., your name and signature on the consent forms, your date of birth on the W-9) or data drives containing driving data will be stored in a locked container in the cargo storage compartment of the vehicle during transport from the meeting location to the research facility.

All data collection equipment is mounted in the vehicle such that, to the greatest extent possible, it does not pose a hazard in any foreseeable case. None of the data collection equipment will interfere with any part of the driver's normal field of view.

Commonly touched areas of the vehicle, such as door handles and the steering wheel, will be disinfected before the vehicle is returned to you following instrumentation.

The data collected from the vehicle and the video data will be encrypted at the onset of collection on the data drive in the vehicle. The data remain encrypted until uploaded to a secure VTTI server.

To help us further protect your privacy, a Certificate of Confidentiality will be sought to prevent the continuous video and sensor data from being used against you in the event of an at-fault collision.

Reducing Risk During Intake Assessments:

The balance assessment will be completed next to a wall in an area free of clutter or other obstructions. The researcher will give you the choice to have the researcher stand near you or to have a stationary walker in front of you for balance assistance as needed.

To reduce risk of physical discomfort during the flexibility assessment, the researcher will ask you to look over your left shoulder within comfortable limits.as you would when making a left lane change.

Reducing Risk During Driving Period:

The driving plan we present to you during the second month of your participation is designed to reduce driving risk.

We have placed a letter in the glovebox which can be used to demonstrate the vehicle's role in the study while still maintaining your privacy and confidentiality. Should a law enforcement officer or other authority ask about the data

collection equipment in the study vehicle, please let him or her know about the letter we have provided that explains the presence of the equipment before reaching for the letter.
You are instructed to conform to the laws and regulations of driving on public roadways.
We will do our best to not collect identifying video information on passengers in the vehicle; however, passengers sitting right behind the driver will be the most vulnerable to being seen on video. Should the cameras capture images of passengers, these images will be blurred.

Can I be removed from the research without my OK?
The person in charge of the research study or the sponsor can remove you from the research study without your approval. Possible reasons for removal include being uncooperative (i.e., not following instructions) or habitually driving or otherwise behaving in an unsafe manner, or the sponsor choosing to end the study or your participation before the originally scheduled end date. If you are not the owner, co-owner, or lessee of the vehicle and the owner decides to withdraw the vehicle from the study earlier than your planned term of enrollment, you will be removed from study.
We will tell you about any new information that might affect your health, welfare, or choice to stay in the research.

What else do I need to know?
This research is being funded by the National Surface Transportation Safety Center for Excellence (NSTSCE) and the Center for Advanced Transportation Mobility.

Study Compensation

If you agree to take part in this research study, you will receive compensation for your time and effort. After you sign the consent form, we will issue you a ClinCard MasterCard, and funds will be loaded onto the card in three installments following study appointments as follows:
Following your initial appointment to provide consent, complete intake surveys and assessments, and have your vehicle instrumented, $200 for those activities will be added to the ClinCard. Additionally, $25 compensation for completing the Phase 1 SAGE assessment will be added at this time, for a total of $225 following the initial appointment,
Each month of the driving period, you will receive $50 monthly compensation, for a total of $150 for 3 months. If you withdraw from the study early, compensation for the naturalistic driving period will be prorated at $1.67 per day.
$75 will be loaded onto your card following the driving consultation.
After we remove the equipment from the vehicle at the end of the study, we will add $50.
Total maximum compensation for full participation is $500.

In the event we schedule additional appointments for maintenance outside the scheduled data drive swap after the first month of the driving period, an inconvenience fee will be loaded onto your ClinCard.
If a researcher comes to your home to perform this maintenance, $10 will be loaded onto your card.
If we ask you to meet us at a location convenient to your home to have this maintenance performed, $25 will be added to your card.
If you choose to have your vehicle driven to VTTI for vehicle-related appointments, funds will be added to your ClinCard to reimburse you for mileage at a rate of 59 cents per mile.
Such payments would be in addition to the maximum compensation amount identified above.
.
Participants in a study are considered volunteers, regardless of whether they receive compensation for their participation. Under state law, workers compensation does not apply to volunteers; therefore, the participants are responsible for their own medical insurance for bodily injury. Appropriate health insurance is strongly recommended to cover these types of expenses.
If you get hurt in a crash, whether in or out of an automobile, the medical treatment available to you would be that provided to any person by emergency medical services in the vicinity where the accident occurs.
Under the policies of the Commonwealth of Virginia, insurance coverage follows the ownership of the vehicle. Therefore, if the owner of the car gives a VT employee permission to drive their vehicle, and that employee has a crash, there would

be no coverage under Virginia's auto liability plan. The owner of the car should file a claim with their insurance provider, as desired.
The participant agrees that this agreement shall be construed in accordance with the laws of the Commonwealth of Virginia, notwithstanding any conflicts of law provisions. Further, any and all claims and/or actions against Virginia Tech or the Commonwealth of Virginia shall be brought in a court of the Commonwealth of Virginia.
Who can I talk to?
If you have questions, concerns, or complaints, or think the research has hurt you, you can talk to Brian Wotring at (540) 315-1086 or you can email him at bwotring@vtti.vt.edu.
This research has been reviewed and approved by the Virginia Tech Institutional Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:
You have questions about your rights as a research subject.
Your questions, concerns, or complaints are not being answered by the research team.
You cannot reach the research team.
You want to talk to someone besides the research team to provide feedback about this research.

By signing below, you affirm that:
You will not remove, modify, or tamper with any of the installed components.
You will not block the forward or driver's face cameras and not to hang decorative ornaments on study components or the rearview mirror.
You will notify research staff if you are involved in a crash, encounter any problems with the study vehicle, or if you have questions.
You understand that we will not share your study data with you
Cameras will record video of your face and the forward roadway and
The rear roadway
the instrument panel
the dashboard and steering wheel
the turn signal stalk

Signature of subject	Date
Printed name of subject	
Signature of researcher obtaining consent	Date
Printed name of researcher obtaining consent	

Initial and date below to indicate ongoing consent to participate in study activities:

After Driving Consultation Meeting
By initialing below, I am reaffirming my consent to continue participation in the study.

Initials of subject	Date

APPENDIX B – SAGE ASSESSMENT AND SCORING RUBRIC

How Well Are You Thinking?

Please complete this form in ink **without** the assistance of others.

How far did you get in school?_____

Have you had any problems with memory or thinking? Yes_____Only Occasionally_____No_____

Have you had any blood relatives that have had problems with memory or thinking? Yes_____No_____

Do you have balance problems? Yes_____No_____

If yes, do you know the cause? Yes (specify reason)_____No_____

Have you ever had a major stroke? Yes_____No_____A minor or mini-stroke? Yes_____No_____

Do you currently feel sad or depressed? Yes_____Only Occasionally_____No_____

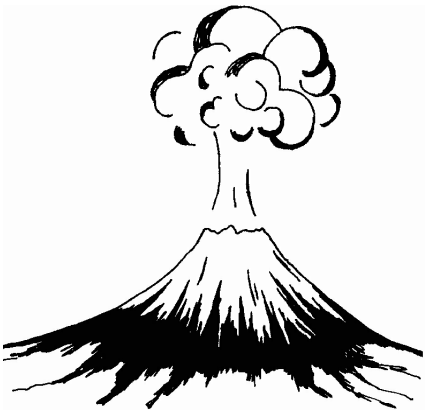
Have you had any change in your personality? Yes (specify changes)_____No_____

Do you have more difficulties doing everyday activities due to thinking problems? Yes_____No_____

1. What is today's date? (from memory – no cheating!) Month_____Date_____Year_____

2. Name the following pictures (don't worry about spelling):

_____



_____

Answer these questions:

3. How are a watch and a ruler similar? Write down how they are alike. They both are… what?

_____

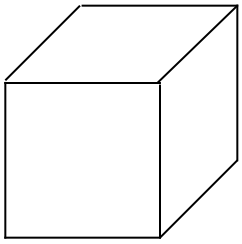
4. How many nickels are in 60 cents? _____

5. You are buying $13.45 of groceries. How much change would you receive back from a $20 bill?

6. Memory Test (memorize these instructions). Do later only after completing this entire test:

At the bottom of the very last page: Write "I am done" on the blank line provided.

7. Copy this picture:



8. Drawing test

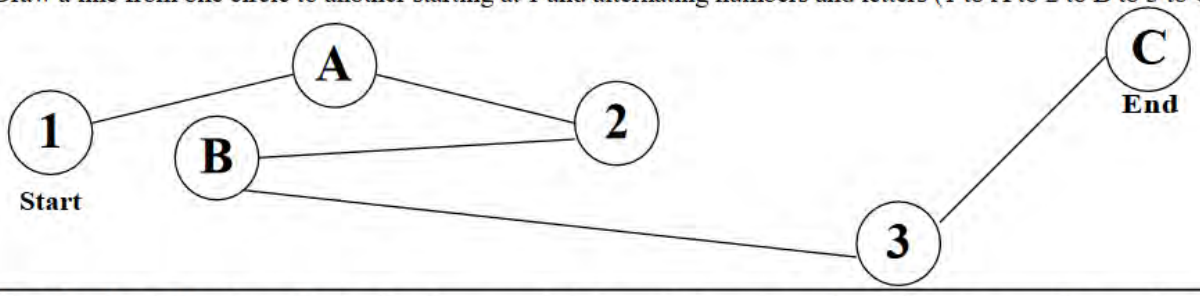
- Draw a large face of a clock and place in the numbers
- Position the hands for 5 minutes after 11 o'clock
- On your clock, label "L" for the long hand and "S" for the short hand

9. Write down the names of 12 different animals (don't worry about spelling):

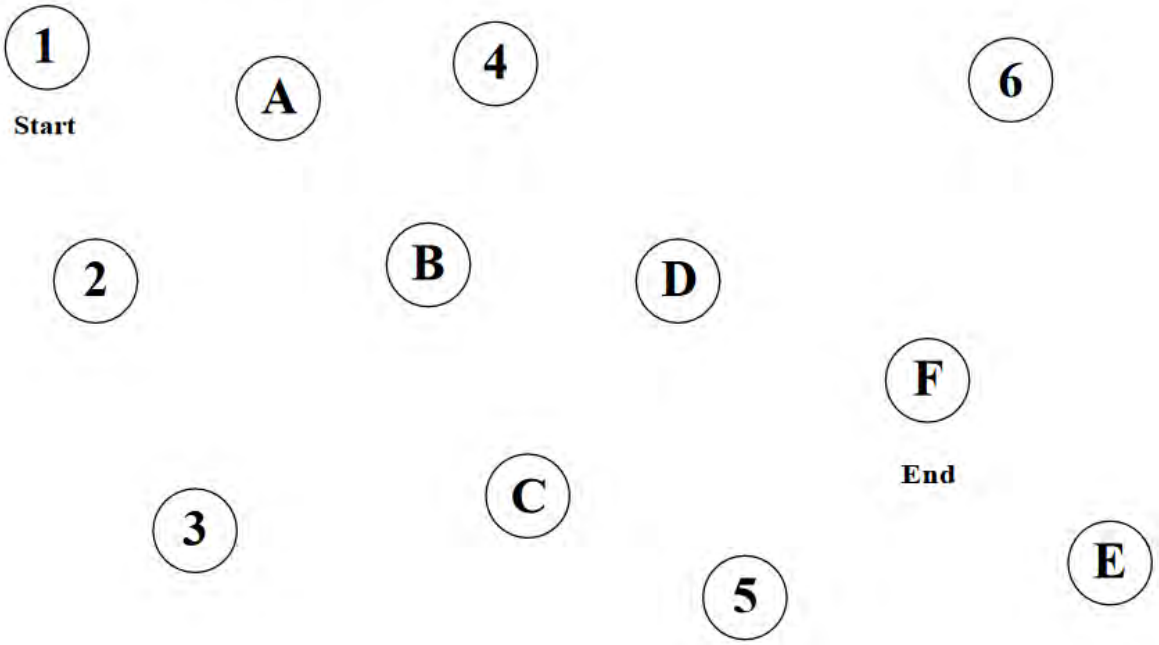
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Review this example (this first one is done for you) then go to question 10 below:

Draw a line from one circle to another starting at 1 and alternating numbers and letters (1 to A to 2 to B to 3 to C).

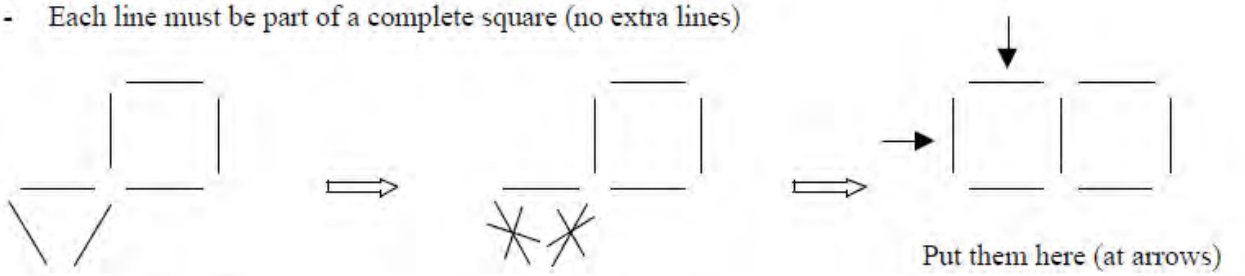


10. Do the following: Draw a line from one circle to another starting at 1 and alternating numbers and letters in order before ending at F (1 to A to 2 to B and so on).



Review this example (this first one is done for you) then answer question 11 below:

- Beginning with 1 triangle and 1 square
- Move 2 lines (marked with an X)
- To make 2 squares and no triangle
- Each line must be part of a complete square (no extra lines)



1 triangle, 1 square

(Example)

Move these 2 lines

(Example)

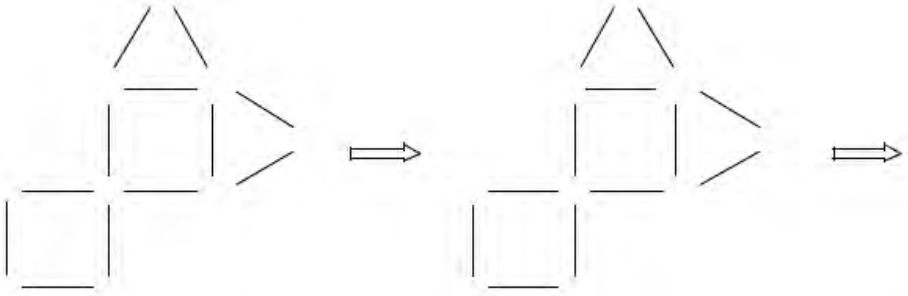
Put them here (at arrows)

Makes 2 squares (answer)

(Example)

11. Solve the following problem:

- Beginning with 2 squares and 2 triangles
- Move 4 lines (mark with an X)
- To make 4 squares and no triangles
- Each line must be part of a complete square (no extra lines)



2 squares, 2 triangles

Move 4 lines

Mark with an X

Draw answer here

4 squares

12. Have you finished? _____

Self-Administered Gerocognitive Examination (SAGE) Administration and Scoring Instructions

SAGE is a brief self-administered cognitive screening instrument to identify Mild Cognitive Impairment (MCI) and early dementia. Average time to complete the test is 15 minutes. The maximum score is 22. A score of 17 and above is considered normal.

Administration:

The test is self-administered. It should be filled out in ink without the assistance of others. Inform the examinee that there are four pages to complete. Calendars and clocks should not be available during the testing. Do not answer specific questions. Just say, "Do the best that you can".

Non-Scored Items:

Demographics

Insight: Have you had any problems with memory or thinking?

Family History

Motor symptoms

Stroke symptoms

Depression symptoms

Personality changes

Functional abilities

Scored Items:

1. Orientation: Total possible points are 4

Month:	1	=	Correct
	0	=	Incorrect
Date:	2	=	exact
	1	=	± 3 days
	0	=	All else
Year:	1	=	Correct
	0	=	Incorrect

2. Naming: Total possible points are 2. Correct spelling not required.
   Each Picture:
   1 = Correct
   0 = Incorrect

3. Similarities: Total possible points are 2. Correct spelling/grammar not required.
   2 = Abstract
   1 = Concrete
   0 = All else

4. Calculation: Total possible point is 1.
   1 = Correct
   0 = Incorrect

5. Calculation: Total possible point is 1.
   1 = Correct
   0 = Incorrect

6. Memory: Points given below in twelve.

7. Construction: Total possible points are 2.
   3-D figure:
   2 = 3-D, parallel lines within 10° and correct shape
   1 = 3-D but lines not parallel within 10° or otherwise incorrect shape
   0 = All else

8. Construction: Total possible points are 2.
   Clock: 4 components: Clock face, clock numbers (all 12 numbers in correct order clockwise and approximately correct quadrant position), hand positions (hands to correct time and must be joined near clock center), and hand size (actual or if labeled correctly)

   2 = 4 of 4 components correct
   1 = 3 of 4 components correct; one of the three correct components must be hand positions
   0 = All else

9. Verbal fluency: Total possible points are 2. Correct spelling not required.
   2 = 12 different items listed
   1 = 10 or 11 different items listed
   0 = 9 or less different items listed

10. Executive: Total possible points are 2.
Modified Trails: An error is if two items that should be connected are not or if two items that should not be connected are.

2	=	Perfect or self-corrected errors only
1	=	1 or 2 errors
0	=	More than 2 errors

11. Executive: Total possible points are 2.
Problem solving: Forms 1 and 2:

2	=	Correct lines moved or marked **and** final diagram correct
1	=	Correct lines moved or marked **and** no final diagram drawn **Or** Correct lines moved or marked **but** final diagram incorrect **Or** No lines moved or marked **and** final diagram correct
0	=	All else including lines moved or marked incorrectly **but** final diagram correct

Forms 3 and 4:

2	=	Correct lines crossed out **and** final diagram correct
1	=	Correct lines crossed out **and** no final diagram drawn **Or** Correct lines crossed out **but** final diagram Incorrect **Or** No lines crossed out **and** final diagram correct
0	=	All else including lines crossed out incorrectly **but** final diagram correct

12. Memory: Total possible points are 2.

Forms 1 and 2:

2	=	Exact wording only, nothing extra: "I am done"
1	=	Must contain the word "done": "Yes, I am done", "done", others
0	=	All else

Forms 3 and 4:

2	=	Exact wording only, nothing extra: "I have finished"
1	=	Must contain the word "finished": "Yes, I have finished", "I am finished", "finished", others
0	=	All else

Total points = 0 (minimum) – 22 (maximum)

APPENDIX C – QUESTIONNAIRE ASSESSMENTS

Intake Surveys

Driving Questions

Start of Block: Default Question Block

Q1 I can get where I need to go without too much difficulty.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q33 I generally feel safe when I drive.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q34 I generally feel confident when I drive.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q35 I usually feel calm and relaxed while driving.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q32 Planning routes is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q2 I find it easy to get in or out of my car.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q3 It’s easy to walk between my house and where I usually park my car.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q7 My medications and/or supplements sometimes negatively impact my driving (for instance, making me drowsy, jittery, or slowing my reactions).

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q8 Pain sometimes negatively impacts my driving.

- O Yes
- O No

Display This Question:

If Pain sometimes negatively impacts my driving. = Yes

Q8A Mark all areas of pain that negatively impact your driving and briefly describe the pain.

- ☐ Neck _____
- ☐ Shoulders _____
- ☐ Back _____
- ☐ Hips _____
- ☐ Legs or ankles _____
- ☐ Arms or wrists _____
- ☐ Hands _____
- ☐ Feet _____

Q10 I have a physical impairment that negatively impacts my driving.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q10 I have a mental condition that impacts my driving (for instance, dementia, traumatic brain injury, memory problems, or stroke).

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q12 I have emotional difficulties that impact my driving (for instance, anxiety or past crashes).

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q13 Navigating to an unfamiliar destination is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

End of Block: Default Question Block

Start of Block: Block 1

Q15 Merging is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q17 Making sharp right turns at an intersection is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q18 Staying in my lane on curvy roads is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q19 I usually have no problems obeying traffic signs or signals .

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q20 Backing up is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q21 Changing lanes is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q22 Passing other vehicles is usually easy for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q23 Judging distances is usually easy for me (for instance, safe following, pulling into traffic, or crossing against oncoming traffic [that is, an unprotected left turn]).

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q26 I almost always use my turn signal when changing lanes or making a turn.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q27 I use my headlights when it is dark or raining.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q28 I’m rarely drowsy while driving.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

End of Block: Block 1

Start of Block: Default Question Block

Q8 How often do you engage in each of the following categories of exercise?

	Every day	Often (a few times per week)	Sometimes (a few times per month)	Rarely (once per month or less)	Never
Aerobic exercise or sports (like walking or swimming)	O	O	O	O	O
Flexibility exercise (like yoga or Pilates)	O	O	O	O	O
Muscular exercise (like weights or resistance bands)	O	O	O	O	O

End of Block: Default Question Block

End of Block: Default Question Block

Start of Block: Block 1

Q64 Below is a list of medical conditions, diseases, and medications that may impact driving.
For each condition, Check Yes or No.

Only choose Yes for recent conditions as follows:
---If you were treated for the condition within the past year (such as a doctor's office visit, hospitalization, or surgery), OR

---If you are currently on medication for the condition OR

---If you are using an aid related to the condition (such as corrective lenses, a hearing aid, or a cane) OR

---Currently active health condition.

Q4 Vision conditions, please choose all that apply.

- ☐ Objects far away are blurry when not wearing corrective lenses (e.g., nearsighted).
- ☐ Objects close up are blurry when not wearing corrective lenses (e.g., farsighted).
- ☐ Astigmatism
- ☐ Reading glasses needed
- ☐ Glaucoma
- ☐ Color blindness
- ☐ Blind in one eye
- ☐ Poor night vision
- ☐ Detached retina
- ☐ Tunnel (no peripheral) vision
- ☐ Lasik or similar surgery

Q5 Please select one of the following to describe your use of vision correction aids. Please choose only one of the following:

- O I do not use glasses or contact lenses
- O I use glasses for reading only
- O I use glasses for driving and similar activities only
- O I wear glasses most of the time
- O I wear contact lenses

End of Block: Block 1

Start of Block: Block 2

Q66 The next few questions will ask you about your **hearing**.

Q7 Please choose the following that applies:

- O No hearing difficulties
- O Difficulty hearing, but no hearing aid
- O Hearing aid
- O Deafness

Q9 Heart conditions, please choose all that apply:

- ☐ Angina
- ☐ Angioplasty
- ☐ Heart attack
- ☐ Bypass surgery
- ☐ Pacemaker
- ☐ Congestive heart failure
- ☐ Hypertension (high blood pressure)
- ☐ Hypotension (low blood pressure)

Q11 Stroke or similar brain conditions, please choose all that apply:

- [ ] Stroke
- [ ] TIA (mini-stroke)
- [ ] Brain aneurysm
- [ ] Brain hemorrhage
- [ ] Brain surgery
- [ ] Traumatic brain injury

Q13 Vascular (blood vessel) conditions, please choose all that apply:

- [ ] Peripheral aneurysm (in legs, arms, hands, or feet)
- [ ] Aortic aneurysms
- [ ] Deep-vein thrombosis (blood clot)

Q15 Nervous system conditions, please choose all that apply:

- ☐ Epilepsy
- ☐ Periodic Limb Movement Disorder
- ☐ Parkinson’s Disease
- ☐ Multiple Sclerosis
- ☐ Migraines
- ☐ Dizziness
- ☐ Brain tumors
- ☐ Peripheral Neuropathy (numbness and tingling in hands, feet, arms, and legs)

End of Block: Block 2

Start of Block: Block 3

Q17 Sleep disorders or conditions, please choose all that apply:

- ☐ Regular loud snoring (as reported by spouse or other)
- ☐ Sleep Apnea
- ☐ Insomnia
- ☐ Narcolepsy
- ☐ Restless Leg Syndrome
- ☐ Shift Work Disorder

Q18 Respiratory conditions, please choose all that apply:

- ☐ Asthma
- ☐ Chronic Obstructive Pulmonary Disease (COPD)

Q20 Diabetes, please select the type of diabetes you have.

- O Type 1: Insulin dependent
- O Type 2: Non-insulin dependent
- O Type 2: Insulin dependent
- O None

Q61 Do you have a thyroid condition?

- O Yes – Hyperthyroidism
- O Yes – Hypothyroidism
- O No

Q22 Do you have chronic kidney failure?

- O No
- O Yes

Q24 Do you have severe arthritis?

- O No
- O Yes

Display This Question:

If Do you have severe arthritis? = Yes

Q24A Please briefly describe your severe arthritis.

Q27 Do you have any muscle or movement disorders?

- O No
- O Yes

Display This Question:

If Do you have any muscle or movement disorders? = Yes

Q27A Please briefly describe your muscle or movement disorders

Q29 Which of the following do you use on a regular basis? Please choose all that apply:

- ☐ Crutches
- ☐ Cane
- ☐ Walker
- ☐ Wheelchair
- ☐ Other _____

Q31 Psychiatric conditions, please choose all that apply:

- ☐ Anxiety or panic attacks
- ☐ Depression
- ☐ ADD / ADHD / Tourette's Syndrome
- ☐ Personality disorders
- ☐ Psychotic disorders
- ☐ Bipolar disorder

End of Block: Block 3

Start of Block: Block 5

Q35 My doctor has told me in the past year, that my *medication(s)* may negatively impact my driving.

- O No
- O Yes

36. My doctor has advised me to limit or stop driving because of my health.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

Q38 Are there any other medical issues or concerns not reflected above that may impact your driving?

O No

O Yes

Display This Question:

If Are there any other medical issues or concerns not reflected above that may impact your driving? = Yes

Q38A Please briefly describe the other medical issues or concerns that may impact your driving.

End of Block: Block 5

Start of Block: Block 4

Start of Block: Default Question Block

Q1
This sign may be posted:

- O At no-parking areas
- O Near hospitals
- O At roundabouts
- O In work zones

02
This warning sign means:

- O The road ahead curves to the right and then to the left
- O The road ahead curves to the right
- O A winding road
- O Sharp right and left turns are ahead

Q4

What does this sign indicate?

- O You must make a right turn
- O You may go straight or turn right
- O You must go straight
- O You may go straight or turn left

Q5

What does this traffic sign mean?

- O A parking zone is ahead
- O An alternative route is 1000 feet ahead
- O There is construction ahead in 1000 feet
- O Turn right after 1000 feet

Q6

What does this sign mean?

- O You are approaching a divided highway
- O Keep right of the divider
- O You will have to detour
- O Keep left of the divider

Q7

What does this flashing arrow panel mean?

- O Flag persons (flaggers) are ahead
- O The lane ahead is open to traffic
- O The left lane is winding ahead
- O The lane ahead is closed

Q8

What does this sign indicate?

- O The minimum allowable speed in a school zone at any time
- O The maximum allowable speed in a school zone when children are present
- O The maximum allowable speed in a school zone at any time
- O The minimum allowable speed in a school zone when children are present

Q9

This sign and pavement markings allow:

- O Vehicles from either direction to make a left turn
- O Vehicles from either direction to pass
- O Vehicles from either direction to make a right turn
- O None of the above

Q10

When you see this road sign, you should:

- O Increase your speed to 30 mph and pass the vehicle in front of you
- O Exit the highway with a speed of 30 mph or less
- O Exit the highway with a maximum speed of 60 mph
- O Exit the highway with a minimum speed of 30 mph

End of Block: Default Question Block

Start of Block: Default Question Block

Q7 Select the location that best describes your living location.

- O Urban
- O Suburban
- O Semi-rural
- O Rural

Q58 I can live my life and manage my affairs independently.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q11 I have reliable Internet access from my home.

- O Yes
- O No

Display This Question:

If I have reliable Internet access from my home. = No

Q12 Reliable Internet access is available in my area.

- O Yes
- O No
- O I don't know

Q17 I own a computer, smartphone, or tablet.

- O Yes
- O No

Display This Question:

If I own a personal computing device such as a computer, smartphone, or tablet. = Yes

Q64 I am comfortable using my device(s) to browse the Internet.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Display This Question:

If I own a personal computing device such as a computer, smartphone, or tablet. = Yes

Q65 I am comfortable using my device(s) to help plan a route ahead of time.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q59 I sometimes use a navigation system while driving.

- O Yes
- O No

Display This Question:

If I own, and sometimes use, a navigation system while driving (either built-in, add-on navigation d... = Yes

Q61 I am comfortable entering or searching for a destination with my navigation system.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Display This Question:

If I own, and sometimes use, a navigation system while driving (either built-in, add-on navigation d... = Yes

Q62 I am comfortable following directions from my navigation system while driving.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

End of Block: Default Question Block

Start of Block: Block 1

Q19 How many drivers in your household have access to a vehicle?

- O None
- O 1-2
- O 3-4
- O 4 or more

Q20 My *planned* transportation needs (such as to church, medical appointment, etc.) are usually met.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q57 My *unplanned* transportation needs (such as to visit an ill friend, trip to the drugstore) are usually met.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q22 Over the past 3 months, I frequently relied on others for transportation.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q24 When needed, my friends and family are often available to assist me with my transportation needs (such as by helping me into or out of my vehicle, starting or warming up my car, providing a ride, etc.)?

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q82 I am rarely dependent on family and friends for transportation needs.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q63 I want to be less dependent on family and friends for transportation needs.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q83 Please list your 5 most common destinations (such as Walmart in Christiansburg or Kroger on South Main St. in Blacksburg)

- O First Location _____
- O Second Location _____
- O Third Location _____
- O Fourth Location _____
- O Fifth Location _____

Q25 I am comfortable driving...

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
During the day in good weather	O	O	O	O	O
When it is raining or the roads are wet	O	O	O	O	O
At night	O	O	O	O	O
In heavy traffic in my area	O	O	O	O	O
On the highway or interstate	O	O	O	O	O
Driving alone	O	O	O	O	O
	O	O	O	O	O
Merging	O	O	O	O	O
	O	O	O	O	O
To a destination more than 3 miles away	O	O	O	O	O

Page Break

Q26 Are there specific intersections that cause you concern?

- O Yes
- O No

Display This Question:

If Are there specific intersections that cause you concern? = Yes

Q71 Where is this intersection located?

Display This Question:

If Are there specific intersections that cause you concern? = Yes

Q72 What about this intersection causes you concern?

Q68 Are there specific roadways or highways that cause you concern?

- O Yes
- O No

Display This Question:

If Are there specific roadways or highways that cause you concern? = Yes

Q73 Where is this roadway located?

Display This Question:

If Are there specific roadways or highways that cause you concern? = Yes

Q74 What about this roadway causes you concern?

Q69 Are there specific merging locations, such as on-ramps, that cause you concern?

O Yes

O No

Display This Question:

If Are there specific merging locations, such as on-ramps, that cause you concern? = Yes

Q75 Where is this merging location or on-ramp located?

Display This Question:

If Are there specific merging locations, such as on-ramps, that cause you concern? = Yes

Q76 What about this merging location or on-ramp causes you concern?

Q70 Are there other specific areas that cause you concern that are not covered in the above?

O Yes

O No

Display This Question:

If Are there other specific areas that cause you concern that are not covered in the above? = Yes

Q77 Where is this other area located?

Display This Question:

If Are there other specific areas that cause you concern that are not covered in the above? = Yes

Q78 What about this location causes you concern?

Q67 My personal vehicle is safe.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q27 My personal vehicle is reliable.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q27 My personal vehicle is easy to drive.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q28 My personal vehicle is comfortable.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q29 The main displays and controls in my car are easy to use (for instance, the speedometer, tachometer, pedals, and gear shifter).

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q81 The advanced features in my car are easy to use (for instance, adaptive cruise control, lane centering, etc.).

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q41 I am comfortable using the following advanced safety features

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree	My car doesn't have	Unsure if my car has	Do not know what this is
Adaptive cruise control (ACC)	O	O	O	O	O	O	O	O
Blind spot warning (BSW)	O	O	O	O	O	O	O	O
Blind spot intervention (BSI)	O	O	O	O	O	O	O	O
Lane keep assist (LKA)	O	O	O	O	O	O	O	O
Lane centering (LC)	O	O	O	O	O	O	O	O
Lane departure warning (LDW)	O	O	O	O	O	O	O	O
Automatic emergency braking (AEB)	O	O	O	O	O	O	O	O

Rear emergency braking (REB)	O	O	O	O	O	O	O	O
Backing camera	O	O	O	O	O	O	O	O
Rear cross traffic alert (RCTA)	O	O	O	O	O	O	O	O

Q34 What prevents you from using these services more? Check all that apply:

	Too expensive	Too difficult to access	Too difficult to schedule	Don't feel safe (loading zones, crime, etc.)	Too difficult to figure out how to use	Does Not go where I want to go	Choose not to use	Not available to me	Physical limitation prevents me	Other
Ride-share (like Uber or Lyft)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Volunteer ride service	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Taxi	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Van services	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Public or regional bus	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ADA or Paratransit	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Display This Question:

If What prevents you from using these services more? Check all that apply: = Ride-share (like Uber or Lyft) [Other]

Or What prevents you from using these services more? Check all that apply: = Volunteer ride service [Other]

Or What prevents you from using these services more? Check all that apply: = Taxi [Other]

Or What prevents you from using these services more? Check all that apply: = Van services [Other]

Or What prevents you from using these services more? Check all that apply: = Public or regional bus [Other]

Or What prevents you from using these services more? Check all that apply: = ADA or Paratransit [Other]

Q42 If you selected "other" as a reason which prevents you from using a service in the previous question, describe why:

- Ride-share (like Uber or Lyft)_____
- Volunteer ride services_____
- Taxi_____
- Van services_____
- Public or regional bus_____
- ADA or paratransit_____

Q43 What prevents you from getting rides from friends or family? Check all that apply:

- Do not need rides
- Too difficult to schedule
- Do not live close enough to them
- Choose not to use
- I do not want to be a burden
- Not available to me
- Other (optional comment) _____

Q44 What prevents you from walking more? Check all that apply:

	I do not have a walking limitation	Physical limitation prevents me	No sidewalk or bicycle lane	Other
Walking	☐	☐	☐	☐

Display This Question:

If What prevents you from walking more? Check all that apply: = Walking [Other]

Q45 Please explain why you do not walk more.

Display This Choice:

If What prevents you from walking more? Check all that apply: = Walking [Other]

☐ Walking _____

Q79 What prevents you from bicycling more? Check all that apply:

	I do not have a cycling limitation	Physical limitation prevents me	No sidewalk or bicycle lane	Do not own a bike	Other
Bicycling	☐	☐	☐	☐	☐

Display This Question:

If What prevents you from bicycling more? Check all that apply: = Bicycling [Other]

Q80 Please explain why you do not bicycle more.

Display This Choice:

If What prevents you from walking more? Check all that apply: = [Other]

☐ Bicycling _____

Q66 I currently make purchases online rather than driving to a store.

- O Yes
- O No

Display This Question:

If I currently make purchases online rather than driving to a store. = No

Q56 I do not currently make purchases online because: (check all that apply)

- ☐ Too difficult to figure out how to use
- ☐ I like in-person shopping
- ☐ I do not trust online shopping
- ☐ I have slow or no Internet
- ☐ Other _____

Q37 I currently see a doctor or other provider via telehealth (that is, on the computer or by phone) rather than going to their office.

- O Yes
- O No

Display This Question:

If I currently see a doctor or other provider via telehealth (that is, on the computer or by phone)... = No

Q49 I do not currently use telehealth services because: (check all that apply)

- ☐ Too difficult to figure out how to use
- ☐ I like in-person communication
- ☐ My visits require me to be there in person (for example, I often need lab tests)
- ☐ I have slow or no Internet
- ☐ Other _____

Q38 I currently use meal or grocery delivery services rather than driving to a grocery store or a restaurant.

- ○ Yes
- ○ No

Display This Question:

If I currently use meal or grocery delivery services rather than driving to a grocery store or a res... = No

Q48 I do not currently use meal or grocery delivery services because: (check all that apply)

- ☐ I enjoy grocery shopping or going out for meals
- ☐ Too expensive
- ☐ Too difficult to figure out how to use
- ☐ Do not deliver to my location
- ☐ I don't want a stranger to know where I live
- ☐ Other _____

Q39 I currently use aide services to provide help around the house (such as a home aide or chore service).

- O Yes
- O No

Display This Question:

If I currently use aide services to provide help around the house (such as a home aide or chore serv... = No

Q47 I do not currently use aide services because: (check all that apply)

- ☐ I am capable of living independently
- ☐ Too expensive
- ☐ Too difficult to figure out how to use
- ☐ Service isn't offered in my area
- ☐ I do not trust a stranger in my house
- ☐ Other _____

Q48 Have you had any serious crashes or scary close calls, whether you were at fault or not?

- ☐ No
- ☐ Less than 5 years ago
- ☐ 5-10 years ago
- ☐ More than 10 years ago

Q50 [If yes to Q48] Were you judged to be at-fault?

- ☐ No
- ☐ Yes – optional comment:_____

Q51 [If yes to Q48] Does that event still impact you emotionally or mentally?

- ☐ No
- ☐ Yes – optional comment:_____

Q52 [If yes to Q51] Does that event still impact your confidence while driving?

- ☐ No
- ☐ Yes – optional comment:_____

Q53 How often do you have a front-seat passenger who helps you with your driving, like a co-pilot?

- ☐ Almost all the time
- ☐ Usually
- ☐ Sometimes
- ☐ Infrequently
- ☐ Rarely

Q54 [If Sometimes, Usually, or Almost all the time to Q53] Who primarily serves as your co-pilot?

- ☐ Spouse/significant other
- ☐ Adult child or grandchild
- ☐ Sibling or cousin
- ☐ Friend/roommate/acquaintance
- ☐ Other:_____

Q55 When I have a co-pilot, I am a safer driver

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Q56 When I have a co-pilot, I am less stressed

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Q57 When I have a co-pilot, I am a more confident driver

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

End of Block: Block 1

Start of Block: Default Question Block

Q8 This survey will ask you questions about your socialization opportunities and your social network. For this survey, your social network is considered to be individuals (such as friends, family members, neighbors, etc.) with whom you have a supportive personal relationship.

Q17 Please describe those living with you in order of who is most helpful in terms of driving and mobility:

	Relationship	How old is this individual?	Can this person drive?	
		Age	Yes	No

Individual 1	▼ Spouse ... I live alone		O	O
Individual 2	▼ Spouse ... I live alone		O	O
Individual 3	▼ Spouse ... I live alone		O	O

Q6 How many friends or family members do you have in the local area?

- O None
- O 1
- O 2-3
- O 4-9
- O 10-20
- O More than 20

Q18 How many people are in your in-person social network?

- O 0
- O 1
- O 2
- O 3
- O 4
- O 5
- O 6 or more

Q14 How often do you interact with those in your in-person social network?

- O Never
- O Rarely (less than once per month)
- O Sometimes (a few times per month)
- O Often (a few times per week)
- O Every day

End of Block: Default Question Block

Start of Block: Default Question Block

Q1 I usually feel confident walking up and down stairs.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q5 I usually feel confident walking up or down a ramp.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q7 I usually feel confident walking in a crowd, even if I may be bumped into.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q8 When I am unable to park close to my destination, I have concerns.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q9 [If strongly agree or somewhat agree to 8] I am concerned about:

a. The distance I must walk (SA – SD)
   i. Strongly agree
   ii. Somewhat agree
   iii. Neither agree nor disagree
   iv. Somewhat disagree
   v. Strongly disagree

b. My safety (SA – SD)
   i. Strongly agree
   ii. Somewhat agree
   iii. Neither agree nor disagree
   iv. Somewhat disagree
   v. Strongly disagree

c. Tripping, especially at night (SA – SD)

i. Strongly agree
ii. Somewhat agree
iii. Neither agree nor disagree
iv. Somewhat disagree
v. Strongly disagree

d. Getting lost
i. Strongly agree
ii. Somewhat agree
iii. Neither agree nor disagree
iv. Somewhat disagree
v. Strongly disagree

e. The weather (SA – SD)
i. Strongly agree
ii. Somewhat agree
iii. Neither agree nor disagree
iv. Somewhat disagree
v. Strongly disagree

f. Finding an accessible restroom along the way (SA – SD)
i. Strongly agree
ii. Somewhat agree
iii. Neither agree nor disagree
iv. Somewhat disagree
v. Strongly disagree

End of Block: Default Question Block

Driving Self-Assessment

1. Other drivers seem to be honking at me more than before.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

2. Cars often appear suddenly from nowhere.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

3. Cars often stop suddenly in front of me.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

4. It is easy for me to look over my shoulder to back up or change lanes.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

5. It is usually easy for me to pass through intersections safely.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

6. I often feel overwhelmed when there are too many things to pay attention to (for instance, road signs, signals, pavement markings, pedestrians, and/or other vehicles).
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree

e. Strongly disagree

7. It is easy for me to move my foot from the gas to the brake and turn the steering wheel.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

8. I sometimes get lost on roads that should be familiar to me.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

9. I am confident when driving alone.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

10. I have had very few fender benders in the last 3 years.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

11. I worry that I might make a mistake and hurt myself or others.
    a. Strongly agree
    b. Somewhat agree
    c. Neither agree nor disagree
    d. Somewhat disagree
    e. Strongly disagree

12. I have had police warnings or moving violations in the last 3 years.
    a. Yes
    b. No

Exit Surveys

Post-Experiment Survey

Start of Block: Default Question Block

I can live my life and manage my affairs independently.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q2 I can get where I need to go without too much difficulty.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q5 I generally feel safe when I drive.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q4 I generally feel confident when I drive.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q3 I usually feel calm and relaxed while driving.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q6 My *planned* transportation needs (such as to church, medical appointment, etc.) are usually met.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q7 My *unplanned* transportation needs (such as to visit an ill friend, trip to the drug store, etc.) are usually met.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q8 Over the past 3 months, I frequently relied on others for transportation.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q9 How many people are in your in-person social network?

- O 0
- O 1
- O 2
- O 3
- O 4
- O 5
- O 6 or more

Q10 How often do you interact with those in your in-person social network?

- O Never
- O Rarely (less than once per month)
- O Sometimes (a few times per month)
- O Often (a few times per week)
- O Every day

Optional comment:_____

Q15 In general, my answers to the above questions were due to my involvement in the program.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Q16 The mobility consultation made me feel safer and/or more confident about my driving.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q17 The hands-on personal touch was an important part of the program for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q18 The fact that the program was tailored to my specific needs was an important part of its success.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q12 Participating in this program was worthwhile for me.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q13 If it were made available, I would like to continue with this program.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q14 I would recommend this program to others in my situation.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q16 In general, my overall sense of well-being has improved because of this program.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q18 I made a concerted effort to drive more than I normally would during the study to provide more driving data for the research staff.

- O Strongly agree
- O Somewhat agree
- O Neither agree nor disagree
- O Somewhat disagree
- O Strongly disagree

Optional comment:_____

Q19 Is there anything else you would like to share about this program? (free text)

Semi-Structured Exit Interview Questions for ROADTRIP Participants

1. What motivated you to participate in this study?

2. How did you find the assessment process (for example, completing the medical or road signs questionnaires)?

3. Did you seek out a stakeholder (for example., spouse, adult child, friend) to help or support you throughout this program?

    a. If so, was s/he engaged with you and this program on a regular basis?

4. In general, did you feel like your transportation mobility increased or improved after program implementation? If so, how?

5. In general, did you feel like the non-transportation suggestions increased your access or convenience to services?

6. In what ways did your driving habits change after program implementation?

7. Let's discuss each the intervention we implemented – do you think they made a difference for your safety, confidence, or mobility?

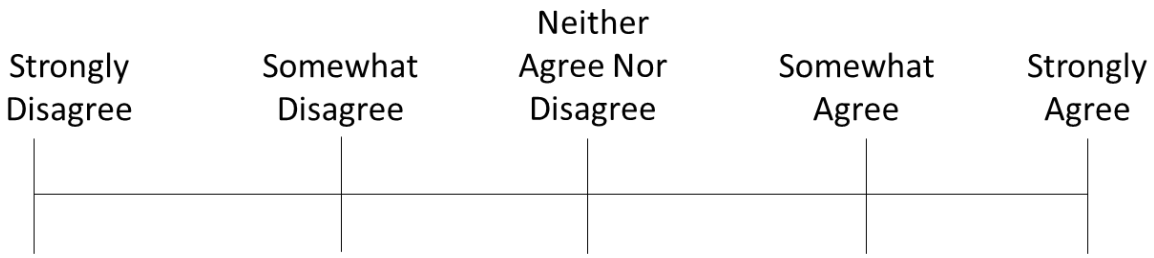
    a. If so, how? (for each intervention that particular participant received)

8. How did your participation in this program increase your awareness of your driving habits?

9. What did you learn about yourself or about your mobility during your participation in this program?

10. Did participation in this program increase your awareness of your car's safety features?

11. My time investment in the program was appropriate for the benefits and information I received.



a)

12. What else would you like to share about your participation in this study?

APPENDIX D – INTERVENTIONS

Vehicle Augmentation

As part of the CarFit service, a sheet showing several images of driver aids, along with a handful used for demonstration purposes, were shown to the older driver and discussed if any interest was expressed (pictured below).

Instrument Cluster Customization

If a participant drove a vehicle with a customizable instrument cluster, the researcher worked with the participant to customize it in such a way to improve usability. If a participant did not have a customizable instrument cluster, the researcher attempted to discuss the issues with the participant to improve usability.

Route Finding

The benefits of route changes were discussed with the participant, as well as general tips such as three lefts instead of a right or taking back roads instead of main highways. Suggestions were also made that the participant may benefit from the use of a navigation system to travel to lesser-known areas or as additional information to help with typical route finding. As part of the assessment process, common destinations and those known to cause issues or stress were noted. The researcher brought these up on Google Maps to discuss the location and suggest any routing changes that may be beneficial.

Avoidances

Similar to route finding above, if the assessment process determined avoiding or restricting driving in key locations (e.g., complex intersections or at night), the researcher discussed why these can be a safety issue and engaged in a conversation to determine an alternative strategy.

ADAS Training

The primary method in which the researcher engaged in ADAS training was through the MyCarDoesWhat website (https://mycardoeswhat.org/), supported by the National Safety Council. At the time of this effort, three ADAS were not featured on the website, so the researcher presented a video, sponsored by NHTSA, to the participant for two of the items. Finally, for one system, lane centering, a NHTSA website was utilized that explained the system. If the participant had any questions, the researcher answered and explained the systems further. The websites and videos are linked below:

- Lane Centering
  - https://www.nhtsa.gov/equipment/driver-assistance-technologies#driving-control-assistance-30676
- Blind spot intervention
  - https://www.youtube.com/watch?v=SGiTwBEzLEA
- Rear emergency braking
  - https://www.youtube.com/watch?v=81yyC3dlW94

Standard Features

If a discussion of standard vehicle features was warranted, the researcher utilized the MyCarDoesWhat website (https://mycardoeswhat.org/), supported by the National Safety Council, to discuss the feature with the participant. Any remaining questions were answered or explained further. These features may include items such as blind spot warning systems, windshield wiper settings, or use of Bluetooth phone connectivity.

Driver Refresher Courses

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

AAA Virginia Online Defensive Driving Program

- $45 ($39 if you are an AAA member)
- 8 hours
- Online course
- https://www.aaadriverprogram.com/

AARP Virginia 8-Hour Smart Driver Course

- $27.95 ($21.95 if you are an AARP member)
- State-specific
- 8 hours
- Online course
- https://www.aarpdriversafety.org/why-take-our-course.html

Mature Driver Course

- $20
- State-specific
- 8 hours
- Online course
- https://www.maturedrivercourse.com/

New River Valley Driving school

- $65
- Local

- 8 hours
- In-person
- http://www.newrivervalleydrivingschool.com/
- 540-381-3375

Virginia Mature Driver

- $25
- State-specific
- 8 hours
- Online course
- https://trafficschoolonline.com/virginia-mature-driver

Tips on How to be a Good Copilot

1. Be supportive and encouraging.
2. Monitor the roadway for potential threats such as:
    a. Deer or other animals
    b. Surrounding traffic
    c. Weather conditions
    d. Objects in roadway
3. Help the driver navigate by pointing out relevant road signs or landmarks ahead of time. This will help the driver not feel rushed when a decision point is reached.
4. Pay attention to the driver's emotional and physical state.
5. Help the driver navigate maneuvers such as lane changes or merges by attending to the traffic around them.
6. Watch for oncoming traffic when pulling onto a roadway or across traffic.
7. Pay attention to the distance to the vehicle in front of you. If the driver is following too closely, suggest that they increase headway.
8. Be ready to switch places and drive if needed (assuming you are able to do so safely).

Navigation System Training Protocol

1. Determine the type of navigation system the participant would like to use:
    a. Phone
    b. Add-on navigation
    c. Built-in navigation

Phone

2. Pair with vehicle.
3. Demonstrate how to mount device to holder.
4. Open Apple maps or Google maps.
    a. Can also download Waze if the participant would like
5. Walk through how to navigate, detailing:
    a. How to see your location
    b. How to search for an address or destination
    c. Selecting a destination
    d. Navigation screen
    e. Volume adjustments
    f. How to end a trip

Add-on Navigation

2. Connect navigation system to vehicle power
3. Demonstrate how to mount device to windshield or holder
4. Walk through how to navigate, detailing:
    a. How to see your location
    b. How to search for an address or destination
    c. Selecting a destination
    d. Navigation screen
    e. Volume adjustments
    f. How to end a trip

Built-in Navigation

2. Demonstrate how to access navigation
3. Walk through how to navigate, detailing:
    a. How to see your location
    b. How to search for an address or destination
    c. Selecting a destination
    d. Navigation screen
    e. Volume adjustments
    f. How to end a trip

Alternative Transportation Training Protocol

1. Assess driver's needs to determine whether a bus route or ADA/Paratransit is needed.

Bus

2. Determine the county in which the bus will be utilized.
3. Proceed to the website for the appropriate service.
    a. Montgomery County – Blacksburg Transit
        i. https://ridebt.org/index.php/riding-the-bus
    b. Pulaski County – Pulaski Area Transit
        i. https://www.pulaskitransit.org/schedule.html
    c. Valley Metro – Roanoke
        i. https://valleymetro.com/genrouteinfo.html
    d. Carroll, Grayson, Smyth, and Wythe Counties – Mountain Lynx Transit
        i. http://carrollcountyva.gov/residents_and_community_services/public_transit.php
4. Discuss with driver:
    a. Bus routes
    b. Schedules
    c. Cost
    d. Snow routes

ADA/Paratransit

2. Determine the county in which ADA/Paratransit will be utilized.
3. Proceed to the website for the applicable services.
    a. Montgomery County – BT Access
        i. https://ridebt.org/bt-access/overview
    b. Roanoke – S.T.A.R.
        i. https://valleymetro.com/star.html

4. Discuss with driver:
    a. Restrictions – medical, age, time of day, etc.
    b. Locations – hospital, clinic, etc.
    c. Cost

Ride Share Training Protocol

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

1. Ensure that the participant has a smartphone to support apps.
2. Determine if participant would prefer Uber or Lyft as a ride share service.
3. Download the appropriate app – emphasize the app is free to use, but using rides costs money.
4. Link credit card to the account.
5. Walk through how to request a ride detailing:
    a. How to see your location
    b. How to search for an address or a destination
    c. Available cars in the area
    d. Different options for car choice

6. Tips:
    a. Costs can vary by time of day and day of week, but the price is shown upfront before you select a ride.
    b. Drivers are screened by the company, but that does not guarantee safety.
    c. Drivers are rated based on the number of "stars" they receive. A higher number equals better past service.
    d. Always make sure the license plate and make/model of the vehicle match between what is shown on your app and the vehicle that approaches you.

Geofence

Based on discussions surrounding unsafe or difficult behaviors, the researcher suggests a geofence surrounding certain locations. The locations focused on will be those the participant noted issues with—for example, a complex intersection. In this case, the researcher would discuss alternative routes to navigate to desired locations without passing through that intersection.

Temporal Fence

Based on discussions surrounding unsafe or difficult times of travel, the researcher suggests driving during certain times of the day and avoiding others, likely related to driving at night or difficulties in heavy traffic. The researcher will discuss alternative times to travel to avoid peak traffic while still meeting needs.

Maneuver Coaching

Based on the results of the driving data analyses, the researcher engages in a discussion with the participant surrounding unsafe maneuvers, suggesting changes which would improve safety (e.g., make sure you use turn signals before initiating a lane change). A discussion of why the changes are helpful will occur alongside current risks.

Referrals

As VTTI had no medical professional on staff at the time of this effort, any suggestions related to seeing a medical professional were discussed in terms of encouraging a discussion with the participant's primary care physician. For example, if the algorithm output suggested seeking out a somnologist, the researcher would discuss issues related to drowsy driving and that the participant may want to have a discussion with their physician about drowsiness and perhaps suggest speaking with a sleep professional.

Alternative Transportation Options

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

**Indicates enrollment necessary before using this service*

Bedford

- ***Bedford Ride:** Non-emergency medical transport (requires 2-day notice)
    - 434-385-9070
- ***Dial a Ride:** Transportation to medical appointments, pharmacies & grocery stores (fees based on income, must be 60+, 48-hour notice)
    - 434-385-9070

Botetourt

- ***Botetourt County Van Service, Medical:** Transportation for essential and non-essential appointments (Must be 55+ and have a disability)
    - (540) 314-1782
- ***Vital Services Transportation:** Transportation for those with an emergency need for transport to critical appointments, grocery stores or pharmacy. (Must be 60+ and low-income)

- 540-966-1094
- **City Cab Taxi Service**
  - 540-815-5050

Carroll

- **Eller Taxi Service**
  - 276-759-2200
- **Mountain Lynx Transit:** Provides weekly service to various parts of Carroll County (will pick you up at or near your home with 24-hour notice)
  - 276-236-3055

Craig

- ***Vital Services Transportation:** Transportation for those with an emergency need for transport to critical appointments, grocery stores or pharmacy. (Must be 60+ and low-income)
  - 540-864-6031
- **City Cab Taxi Service**
  - 540-815-5050
- **LifeCare Medical Transport:** Provides emergency and non-emergency medical transport (available 24/7)
  - 540-752-5883
- **Eller Taxi Service**
  - 276-759-2200

Floyd

- **New River Valley Medical Transport:** Non-emergency medical transport for those 60+ or with a disability (fees based on income)
  - 540-980-7720
- **Eller Taxi Service**
  - 276-759-2200

Franklin

- ***Office of Aging Transportation:** Transportation for seniors (requires 3-day notice and fees based on income)
  - 540-483-9238
- ***Office of Aging Transportation: Virginia Premier:** Transportation for Medicaid recipients (requires 5-day notice)
  - 888-338-4579
- ***Southern Area Agency on Aging Transportation Service:** Transportation to medical appointments, senior lunch sites and groceries (must be 60+ and fees based on income)
  - 276-632-6442

Giles

- **New River Valley Medical Transport:** Non-emergency medical transport for those 60+ or with a disability (fees based on income)
  - 540-980-7720

Grayson

- **Mountain Lynx Transit:** Van transportation for residents and visitors of Grayson County (fixed route with deviations possible)

- 276-236-3055
- **Eller Taxi Service**
  - 276-759-2200

Montgomery

- **Blacksburg Transit:** A fixed route bus service (reduced fares for those 65+ or with a disability – exact change required)
  - 540-443-1500
- ***BT Access:** Door-to-door **Paratransit** for people with a temporary or permanent disability
  - 540-443-1533
- **Blacksburg Taxi**
  - 540-552-6671
- **Smart Way Commuter bus:** Bus service linking the NRV to the Roanoke valley (reduced fares for SSI recipients, Medicare cardholders, and people 65+ or with a disability – exact change required)
  - 540-982-2222
- **Virginia Breeze:** Bus service from the NRV to Washington D.C.
  - 877-462-6342
- **Text-a-cab**
  - 540-239-9724
- **Zip Car:** Car sharing alternative for daily and hourly car rental
- **Uber:** Ride share service
- **Lyft:** Ride share service
- **New River Valley Medical Transport:** Non-emergency medical transport for those 60+ or with a disability (fees based on income)
  - 540-980-7720

Pulaski

- **Radford Transit:** Serving the city of Radford with connections to the Pulaski Area Transit (also provides trips to Carillion NRV Medical Center with 24-hour notice)
  - 540-961-8300
- **Pulaski Area Transit:** Bus service with routes to Fairlawn, Dublin, Pulaski, and Christiansburg
  - 540-980-5040
- ***A Better Way Transport:** Non-emergency medical transport for Medicaid recipients
  - 276-613-2127
- **New River Valley Medical Transport:** Non-emergency medical transport for those 60+ or with a disability (fees based on income)
  - 540-980-7720

Roanoke

- **City Cab**
  - 540-815-5050
- **Valley Metro:** Bus system serving Roanoke, Salem, and Vinton (discounted fares for those 65+ or with a disability – exact change required)
  - 540-982-2222
- ***S.T.A.R.:** **Paratransit** for arranged rides within Roanoke, Salem, and Vinton for people with a disability
  - 540-343-1721 (ext. 3)
- **Reid Taxi**
  - 540-344-5555

- **Roanoke Cab**
  - 540-904-9966
- **Uber:** Ride share service
- **Lyft:** Ride share service

Smyth

- **Eller Taxi Service**
  - 276-759-2200
- **Diamond Cab**
  - 276-783-8711
- **Mountain Lynx Transit:** Transit service operating between various parts of Smyth County on specific days of the week
  - 276-782-9300

Wythe

- **276 Express:** Door-to-door non-emergency medical transport
  - 276-613-8776
- **Mountain Lynx Transit:** Van transportation for residents and visitors of Wythe County (fixed route with deviations possible)
  - 276-228-7433

Support Services – General

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

- **New River Valley Resource Guide**
  - The New River Valley Agency on Aging provides information to individuals concerning programs, services and resources for older adults, adults with disabilities, and their care supporters that are available both within the Agency and from other agencies and organization.
- **Senior Navigator**
  - A 501c3 non-profit, our mission is to provide helpful, free resource information associated with aging, disabilities, post-military life, and overall well-being.
- **disAbility Navigator**
  - A 501cs non-profit, this website is designed to help older adults find transportation options throughout the Virginia area.
- **National Aging and Disability Transportation Center**
  - The NADTC's goal is to promote the availability and accessibility of transportation options for older adults, people with disabilities, and caregivers.
- **National Aging and Disability Transportation Center – Transportation Options for Older Adults**
  - This document from the NADTC provides an overview of transportation options and considerations.
- **Roanoke Valley – Aging Well**
  - The Roanoke Valley – Aging Well organization is dedicated to helping aging adults navigate transitions, and age well in their own home and community. It takes a village. We are here to ease the headaches and make Living@Home ™ a reality.
- **Virginia Grand Driver**
  - Virginia GrandDriver is an educational resource designed to provide Virginians with information and resources about staying safe and mobile on the road as you age.

Area Agencies on Aging

New River Valley Agency on Aging – 540-980-7720
https://nrvaoa.org
Serving Giles, Pulaski, Floyd, and Montgomery counties and the city of Radford
Services Provided:

- Medical Transportation
- Congregate Meals
- Elder Abuse Prevention
- Home Delivered Meals
- Homemaker Services
- Information and Assistance
- Legal Services
- Care Coordination
- Ombudsman Program
- Respite Care
- Virginia Insurance Counseling Program (VICAP)

Local Office on Aging – 540-345-0451
https://loaa.org
Serving Roanoke, Craig, Botetourt, and Alleghany counties and the cities of Salem, Roanoke, Clifton Forge, and Covington
Services Provided:

- Vital Services Transportation
- Assisted Transportation
- Care Coordination
- Services for Aging in Place
- Congregate Meals (Diners Clubs)
- Balance Programs
- Care Transitions
- Bingocize
- Meals on Wheels
- Meals on Wheels for Pets
- Nutritional Education and Counseling
- Senior Food Boxes
- Legal and Advocacy Programs
- Ombudsman Program
- Adult Day Care
- Homemaker Services
- Personal Care Services
- Virginia Insurance Counseling Program (VICAP)
- Fan Care and Cooling Assistance
- Donated Medical Equipment
- Benefit Enrollment Assistance

District Three Governmental Cooperative – 276-783-8150
Serving Washington, Smyth, Wythe, Bland, Grayson, and Carroll counties and the cities of Galax and Bristol
Services Provided:

- Mountain Lynx Transit
- Farmer's Market Fresh Produce
- Home Delivered Meals
- Health and Education Programs
- Ombudsman Program
- Legal Aid Services
- Friendship Cafes
- Virginia Insurance Counseling and Assistance Program (VICAP)
- Senior Medicare and Medicaid Program
- Diabetes and Chronic Disease Self-Management Education
- Care Management Services
- Public Guardianship Program
- Veterans Fiduciary and Money Management Program
- Chore and Residential Repair Services
- Homemaker Services
- Care Transitions Intervention Program
- Caregiver Support Groups (in some counties)
- Caregiver Counseling
- Respite (Personal Care) Services

Southern Area Agency on Aging – 276-632-6442
https://www.southernaaa.org
Serving Patrick, Henry, Franklin, and Pittsylvania counties and the cities of Martinsville and Danville
Services Provided:

- Transportation (to senior lunch sites, medical appointments, and grocery shopping)
- Mobility Management Services (local non-emergency medical transportation, wheelchair-accessible transportation for veterans to Salem VA Medical Center and Danville Community-Based Outpatient Clinic, and the volunteer driver program for out-of-town non-emergency medical transportation
- Information and Assistance (help with identifying and arranging needed senior services)
- Senior Employment Services
- Meals Served at Senior Lunch Sites (called "Senior Cafes")
- Recreational Activities
- Health Promotion Activities
- Home Repair
- Insurance Counseling
- Emergency Services (limited financial assistance for basic needs)
- Adult Day Care
- Home-Delivered Meals
- Personal Care
- Respite Care
- Care Coordination
- Chores
- Long-Term Care Ombudsman

- Legal Assistance

Central Virginia Alliance for Community Living, Inc. – 434-385-9070
https://cvacl.org
Serving Bedford, Amherst, Campbell, and Appomattox counties and the cities of Bedford and Lynchburg
Services Provided:

- Dial a Ride (transportation to medical appointments, medical care, pharmacies, and grocery stores *wheelchair accessible vans are available)
- Bedford Ride (volunteer driver program for non-emergency medical services)
- Chronic Pain Self-Management Program (CPSMP)
- Diabetes Self-Management Program (DSMP)
- Chronic Disease Self-Management Program (CDSMP)
- A Matter of Balance (fall-prevention)
- Geri-Fit (physical activity and strength training)
- Walk with Ease
- Healthy Ideas (depression program for older adults with chronic conditions)
- Falls Talk (individual program for those who have experienced a fall or regular loss of balance)
- Meals on Wheels
- Animeals (donated pet food to homebound seniors receiving Meals on Wheels)
- Farm Market Fresh (provides locally grown fruit, vegetables, and cut herbs)
- Nutrition Education
- Information and Assistance (connects seniors to needed services)
- Assessment and Care Coordination
- Options Counseling (person-centered strengths-based counseling)
- Check In (bi-monthly phone check-ins)
- Care Transitions "Take Care" (provides support during transitions in health care settings)
- Personal Care (assistance with personal hygiene, mobility, nutritional support, laundry, and environmental maintenance)
- Weatherization Assistance Program (provides energy-saving improvements designed to lower energy consumption)
- Emergency Home Accessibility and Repair Program
- Residential Repair Program
- Medicare Counseling
- Senior Medicare Patrol (empowers seniors to prevent healthcare fraud)
- Ombudsman
- No Wrong Door Virginia (streamlines access to community support and services)
- Virginia Legal Aid

Support Services – Libraries in Southwest Virginia

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

The following libraries have a variety of community programs and classes for seniors. Offerings vary by location

- **Bedford County Public Library System**
  - 540-586-8911

- https://www.bplsonline.org/

- **Botetourt County Public Library System**
  - https://web.botetourtva.gov/library/
  - Blue Ridge 540-928-2900
  - Buchanan 540-928-3005
  - Eagle Rock 540-928-2800
  - Fincastle 540-928-2700

- **Carroll County Public Library System**
  - https://galaxcarroll.lib.va.us/
  - Galax 276-236-2351
  - Galax-Carroll Regional 276-236-2351
  - Carroll County Public Library 276-728-3334

- **Craig County Public Library**
  - https://craigcountypubliclibrary.org/
  - 540-864-8978

- **Montgomery – Floyd Regional Library System**
  - https://www.mfrl.org/index.php
  - Blacksburg 540-552-8246
  - Christiansburg 540-382-6965
  - Floyd 540-745-2947
  - Shawsville 540-268-1964

- **Franklin County Public Library System**
  - https://www.franklincountyva.gov/156/Public-Library
  - Main Branch Rocky Mount 540-483-3098 ext. 0
  - Westlake Branch Hardy 540-483-3098 ext. 2

- **Giles County Public Library System**
  - https://pearisburglibrary.org/
  - Pearisburg 540-921-2556

- **Wythe-Grayson Regional Library**
  - https://wythegrayson.lib.va.us/
  - Main Office 276-773-2761
  - Grayson County 276-773-3018

- Whitetop 276-388-2873
- Fries 276-744-2225
- Wythe County 276-228-4951
- Rural Retreat 276-686-8337

- **Pulaski County Public Library System**
  - http://www.pclibs.org/
  - Pulaski Library 540-980-7770
  - Charles & Ona B. Free Memorial Library Dublin 540-674-2856

- **Roanoke County Public Library System**
  - https://www.roanokecountyva.gov/library
  - South County (Main Branch) 540-772-7507
  - Bent Mountain 540-929-4700
  - Glenvar (Salem) 540-387-6163
  - Hollins 540-561-8024
  - Mt. Pleasant 540-777-8760
  - Vinton 540-857-5043

- **Smyth County Public Library System**
  - https://scpl.ent.sirsi.net/client/en_US/default/
  - Marion 276-783-2323
  - Chilhowie 276-646-3404
  - Saltville 276-496-5514

Support Services – Online Grocery Shopping Options for Delivery or Pickup

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

Several grocery* stores are now offering online grocery shopping with the option of having your groceries delivered to your home or allowing you to pick them up at the store from the comfort of your vehicle.

Aldi

- Pickup
- Delivery

Food Lion

- Pickup
- Delivery

Kroger

- Pickup

- Delivery

Walmart

- Pickup
- Delivery

*Contact your preferred pharmacy as many also offer delivery options

Support Services – Telehealth

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

1. Many clinics and hospitals offer a telehealth option to patients. A telehealth appointment permits you to see a medical provider by a virtual meeting with your phone or computer.
2. The telehealth option allows you to complete your appointment from the comfort of your home without having to be at the provider's office.
3. If you want to complete your visit over the phone, the provider's office will need your contact information. For a telephone-based telehealth visit, the provider's office will call you to initiate the visit.
4. If you want to complete your visit over a virtual meeting, you must have a computer, tablet, or smartphone with connection to the internet.
    a. An internet connection such as cable will generally provide a better experience than satellite or through the phone system.
    b. The provider will send an email to you with a link to the virtual meeting. Click on that link to begin.
    c. A visit over a virtual meeting will allow the doctor to use the camera on your device (if you have one) to conduct a visual examination.
5. Call the provider's office to determine if your visit can be completed remotely or if an office visit is required.

- **Carillion Virtual Visit Guide**

- **Lewis Gale Physicians Telehealth Guide**

- **Blue Ridge Behavioral Healthcare (a mental health service provider offering telehealth services)**

- **Associates in Brief Therapy Counseling Services (a mental health service provider offering telehealth services)**

ADAS Sensor Re-Calibration After a Crash - Important for Continued Safe Operation

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Introduction

Increasing numbers of new cars are equipped with advanced driver assistance systems (ADAS). Some of the more common ones include:

- Forward collision warning
- Automatic emergency braking
- Adaptive cruise control
- Lane departure warning
- Lane keeping assist
- Blind spot monitoring
- Rear cross traffic alert
- Parking assist/self-parking
- Adaptive headlights that steer with the vehicle
- Automatic headlight high-beam activation and dimming

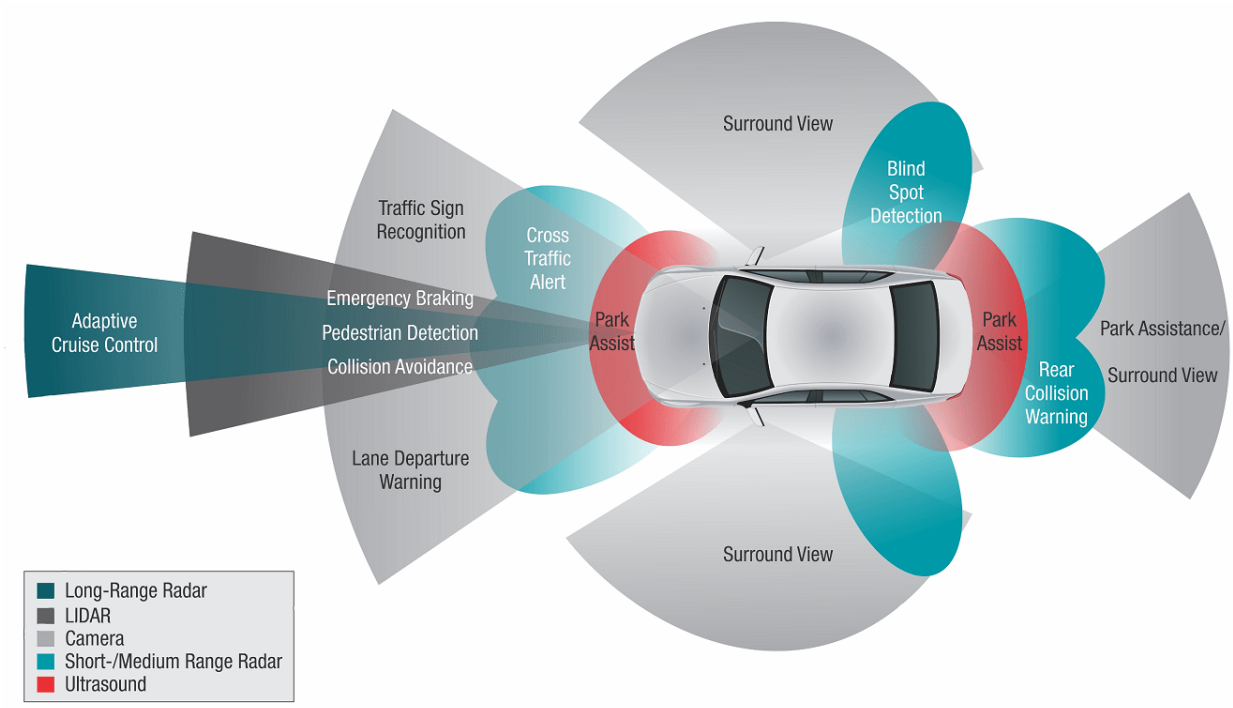


Figure 1. Typical ADAS sensors. LIDAR is not yet used in production vehicles. (Image: Texas Instruments)

To do their jobs, ADAS rely on inputs from a variety of sensors that allow the systems to "see" what is

happening around the automobile. The most common are camera, radar, and ultrasonic sensors. Steering sensors are also used to help determine the direction of vehicle travel. Some systems use information from a single type of sensor, but others combine information from multiple sensors—a process called sensor fusion—to obtain a more accurate "view" of the situation.

Most ADAS sensors are very precisely aimed and require calibration if their positions are disturbed in any way. Consider that a sensor on the car that is out of alignment by a fraction of an inch or even 1 degree will be aimed at an area significantly off-axis 50 or more feet down the road. Misaimed sensors often result from collisions; even a minor fender bender can knock ADAS sensors out of alignment. However, calibration can also be required as a byproduct of common car service work such as windshield replacement, suspension repair, or wheel alignment.

Failure to calibrate a sensor when necessary can result in faulty information that will cause the ADAS to operate improperly or not at all. Faulty sensor input can cause:

- A warning light or message on the instrument panel
- A diagnostic trouble code (DTC) being stored in the vehicle's computer memory
- Steering wheel vibration
- Vehicle steering pull
- Increased steering effort

Problems like these can cause a driver to lose trust in a car's ability to provide safe transportation. ADAS failures may also raise questions about the quality of an auto repair shop's work.

Sensor Types

The most common types of ADAS sensors are cameras, radar units, ultrasonic transmitters, and steering angle sensors. Here is more information about each.

Front-facing Camera Sensors

Many vehicles are equipped with front-facing camera sensors. These sensors are commonly used for automatic emergency braking, adaptive cruise control, lane departure warning, lane keeping assist, and automatic headlight high-beam activation and dimming.

Figure 2. Subaru's dual ADAS camera system. (Image: Subaru)

Because cameras are optical devices that must be able to “see” the road, it is usually easy to identify when a car is equipped with this type of sensor. Many camera sensors mount against the inside of the windshield as part of an assembly integrated with the rearview mirror; others attach to the inside of the roof, either directly or as part of a mirror housing. Some automakers, including Subaru and Land Rover, use dual cameras spaced apart from one another to provide enhanced depth perception.

The high-definition image receptors used in camera sensors are not all that different from those found in other digital camera applications. What makes ADAS camera sensors unique is the high-powered microprocessors and advanced data processing algorithms that are built into the assembly. These components turn the constantly changing analog image the camera sees into digital information that ADAS can use to control various safety-critical systems.

Camera sensors “see” the world through the windshield and are designed for specific rates of light transmission through glass that has minimal imperfections and distortion. A problem in any of these areas can interfere with a sensor’s ability to provide accurate information. Because of this, many automakers specify that only an original equipment manufacturer (OEM) windshield be used if replacement is necessary on a car with a camera sensor. In fact, some car dealers will refuse to calibrate a camera sensor on a car that has an aftermarket windshield installed.

Other Camera Sensors

Some newer cars have 360-degree “around-view” camera systems that use several small cameras at the front, rear, and sides of the vehicle to display an overhead view of the immediate area around the vehicle. These are simpler and lower-resolution cameras than those used for ADAS, although they also require calibration. The cameras are usually located in the front bumper or grille, under the side mirrors, and in the trunk lid or liftgate. The computer controlling the system “stitches” the multiple images together to provide a smooth overall view displayed on the infotainment screen in the dash.

Front-facing Radar Sensors

Adaptive cruise control, forward collision warning, and automatic emergency braking are the ADAS most commonly associated with front-facing radar sensors. The millimeter-wave radar sensors used on vehicles transmit a high-frequency radio signal that reflects off objects and returns to the sensor. The time it takes to receive a return signal is used to calculate the car’s distance from an object.

Figure 3. This “see through” image shows how a radar sensor may be positioned behind a solid plastic cover in the grille. (Image: Mercedes-Benz)

Radar sensors are usually mounted in or behind the front bumper or grille. In a few cases, the radar sensor is mounted in the front-facing camera housing ahead of the rearview mirror. Radio waves can pass through glass and plastic bumper covers or grill materials, and the sensor usually has a cover to protect it from stones and other road debris. While many radar sensors are centrally mounted, others are offset to one side of the automobile, which affects the calibration process.

Because they are sometimes hidden, determining whether a vehicle has a radar sensor can be more difficult than identifying the presence of a camera sensor. If an external visual inspection does not indicate the presence of a sensor, opening the hood could reveal one. Another method is to check for adaptive cruise control switches inside the car (usually on the steering wheel) or a warning light for an automatic emergency braking and/or adaptive cruise control system that illuminates on the dash as a test when the car is first started.

Other Radar Sensors

Some rear collision warning and blind spot monitoring systems use small radar sensors mounted under the side view mirrors, behind the rear bumper cover, or even in the taillights. Bumper- and taillight-mounted sensors may also provide rear cross-traffic alerts when backing out of parking spaces.

To prevent potential interference, most auto manufacturers do not allow repairs to areas of bumper covers that are in front of radar sensors. They also recommend the use of only OEM covers to ensure that the materials used will not interfere with the sensor signals. Excessive bumper cover paint thickness can also be a problem on some vehicles, and automakers advise against placing bumper stickers anywhere near the radar sensors.

Ultrasonic Sensors

Ultrasonic sensors are primarily used for parking assist and self-parking systems. These sensors are installed in the front and/or rear bumper covers where they use reflected high-frequency sound waves (in a manner similar to radar) to detect people, cars, and other objects in close proximity to the vehicle. Sensors of this type on the

sides of cars are used in some self-parking systems and may serve as supplemental sensors in blind-spot monitoring systems.

Figure 4. An ultrasonic sensor on the edge of a wheel well opening. (Image: Wikipedia, Basotxerri, CC BY-SA 4.0)

Ultrasonic ADAS sensors do not require calibration. However, they are designed to be in very precise positions in the bumper cover, or anywhere else they are mounted. For this reason, some automakers do not approve the use of aftermarket, reconditioned, or recycled body parts, which may be distorted or lack pre-drilled holes in the proper locations for mounting the sensors. Although most ultrasonic sensors broadcast a symmetrical circular sound pattern, some generate an asymmetrical oval pattern that requires that they be mounted with a specific orientation to work properly.

Steering Angle Sensors

Steering angle sensors are used in lane departure warning, lane keeping, and adaptive headlight ADAS. The information they provide is also used for other safety and performance-related systems such as electronic stability control and adaptive suspensions. These sensors are usually built into the steering column and measure the degree of steering wheel rotation.

Sensor Calibration

ADAS sensor calibration is required whenever a sensor’s aiming is disturbed in any way. This can occur in a collision, even a minor fender bender, or be a byproduct of common service work such as windshield replacement, suspension repairs, or wheel alignment. Calibration is also called for whenever a sensor or its mounting bracket is removed and replaced, there is a change in tire size, a front airbag deploys and deflects off the windshield, or repairs are made to a car roof that has a sensor bracket mounted to it. Finally, sensor calibration is necessary when there is a related DTC in the car’s computer memory, or an automaker releases a technical service bulletin with instructions that calibration be done as part of another repair.

Sensor replacement and calibration are frequently part of collision repairs. Automakers recommend that body shops now perform a complete diagnostic scan on every vehicle before repairs are begun, and then again after the job is complete. Doing so will help the auto body shop better understand the scope of any problems before

work starts, and then confirm that all issues have been resolved, ADAS sensor calibrations are complete, and the vehicle control systems are communicating properly before the car is returned to the customer.

Figure 5. An aftermarket multi-function automotive diagnostic scan tool. (Image: Snap-On)

Calibrating ADAS sensors is a precision process that is frequently complex and time-consuming. Some sensors can be calibrated in a repair shop, others require that a vehicle be driven, and many sensors call for both procedures. The time involved can vary from 15 minutes to an hour or more, depending on the specific calibration requirements. When necessary, this additional labor adds to the cost of repairs.

Resources for Driving Cessation

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

The following links provide a variety of resources surrounding the topic of driving cessation: from warning signs for dementia to alternative transportation options and helpful tips on beginning the difficult conversation.

- **Dementia and Driving**
- **Warning Signs for Drivers with Dementia**
- **Conversation Planner: How Can I Have Good Conversations About Not Driving?**
- **Driving Activities: Where, When and Why?**

- **Getting There: Using Alternative Transportation**

- **Not Going It Alone: Who Can Offer Support?**

- **Agreement With My Family About Driving**

- **Driving Information and Contract**

    - Note that a driving contract is a key aspect of the current program

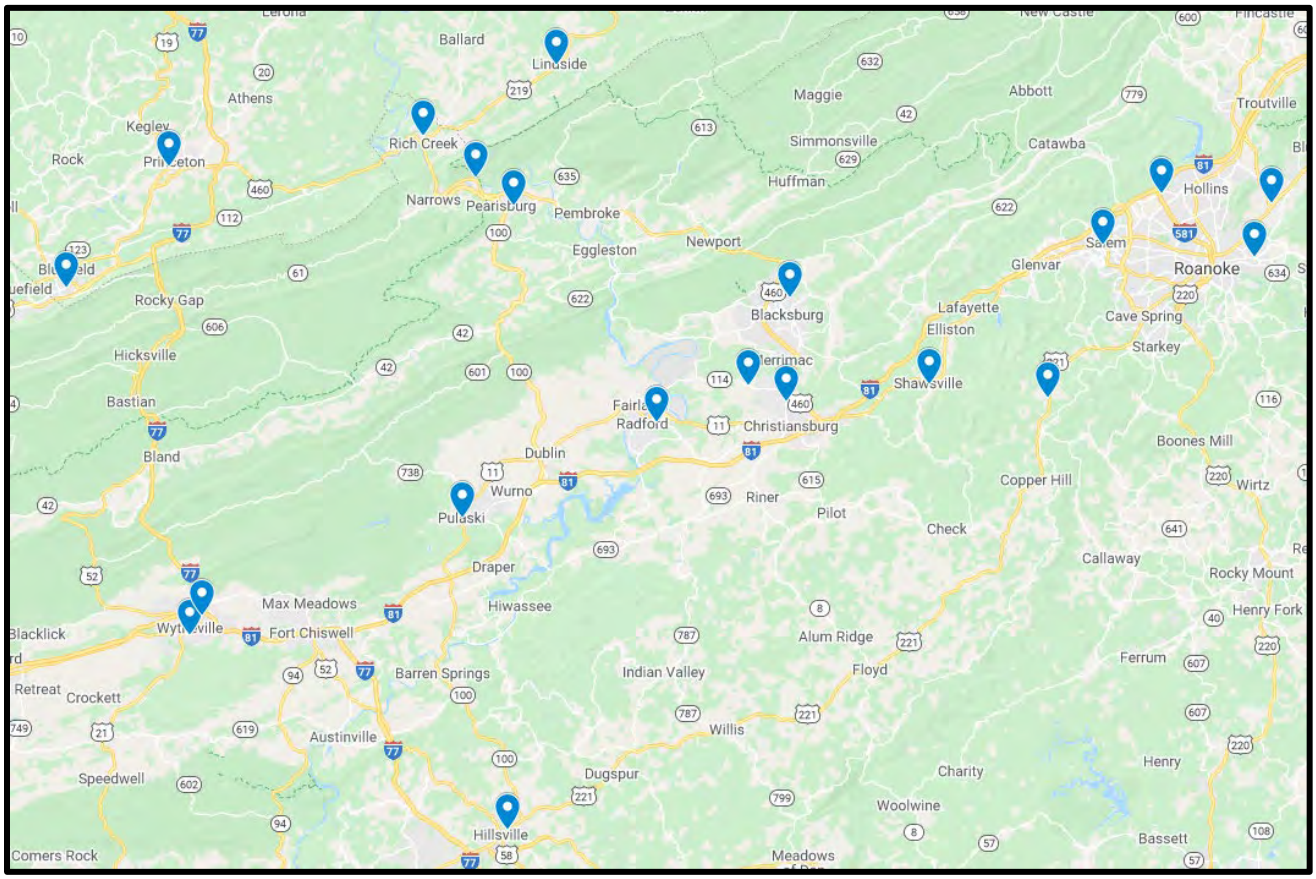
CarFit

CarFit is a national program aimed at helping older adults adjust their vehicle to fit better and thus increase safety. The researcher responsible for administering the program attended a CarFit training session, passed, and conducted the one-on-one session with the participant in the same fashion they would if it occurred at a CarFit event.

Local Senior and Community Centers

VTTI neither endorses nor is affiliated with any of the vendors or organizations listed below, and there is no benefit to us if you should choose to utilize their services. Please use your best discretion in deciding to engage with any vendor or organization.

An interactive version of the map can be found here.



Carroll County

Carroll Wellness Center https://www.carrollwc.org/

- 164 Carter Pines Lane
- Hillsville, VA
- 276-728-2500

Giles County

Giles County Senior Citizens Center **https://virginiasmtnplayground.com/seniors/**

- 1320 Wenonah Avenue
- Pearisburg, VA
- 540-921-3924

Rich Creek Community Center

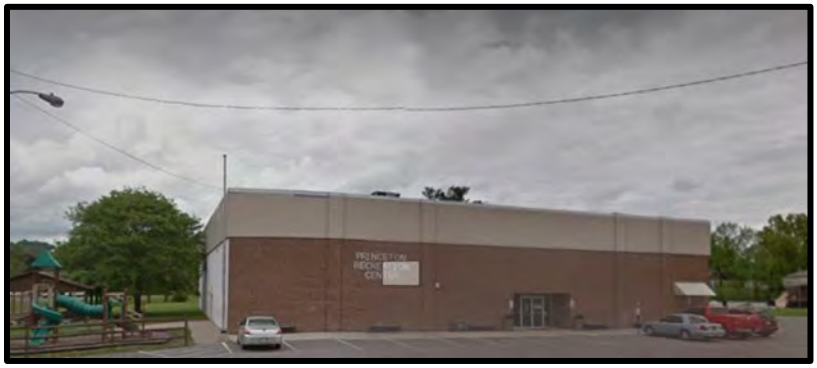
- 140 Spruce Street
- Rich Creek, VA

Giles County Wellness Center https://gilescountywellness.com/GCWC/

- 140 Clendennin Road
- Narrows, VA
- 540-921-4292

Mercer County, WV

Princeton Recreation Center **http://princeton-center4princeton.edan.io/**



- 201 Morrison Drive
- Princeton, WV
- 304-487-5040

Monroe County, WV

Monroe County Senior Center **http://www.mccoawv.net/**

- 8395 Seneca Trail S
- Lindside, WV
- 304-753-4384

Montgomery County

Christiansburg Recreation Center https://www.christiansburg.org/1082/Recreation-Center

- 1600 N. Franklin Street
- Christiansburg, VA
- 540-382-8173

Blacksburg Community Center https://www.blacksburg.gov/departments/departments-l-z/parks-and-recreation/community-center

- 725 Patrick Henry Drive
- Blacksburg, VA
- 540-961-1149

Waldron Wellness Center https://www.eastmontcf.com/waldron

- 267 Alleghany Spring Road
- Shawsville, VA
- 540-268-1623

Pulaski County

Pulaski Senior Center

- 106 N. Washington Avenue
- Pulaski, VA
- 540-994-8627

Roanoke County

Greenridge Recreation Center https://www.roanokecountyparks.com/168/Green-Ridge

- 7415 Wood Haven Road
- Roanoke, VA
- 540-777-6300

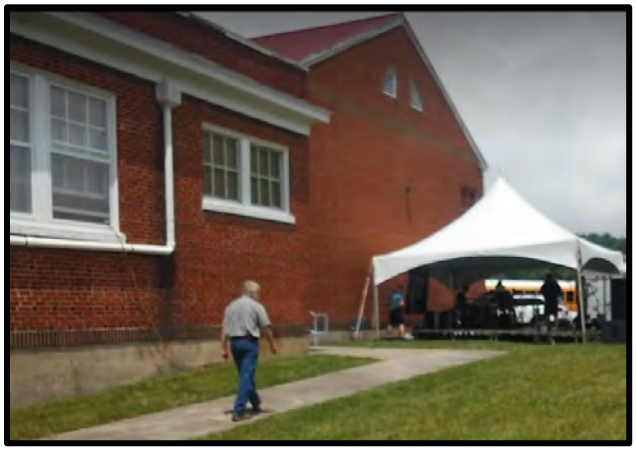
Charles R. Hill Senior Center https://www.vintonva.gov/152/Senior-Programs

- 820 E. Washington Avenue
- Vinton, VA
- 540-983-0643

Bonsack Recreation Center http://www.bonsackclc.org/

- 4845 Cloverdale Road
- Roanoke, VA
- 540-977-5280

Bent Mountain Center https://www.bentmountaincenter.com/



- 10140 Tinsley Lane
- Bent Mountain, VA
- 540-929-4172

Tazewell County

Bluefield Fitness & Recreation Center https://www.cityofbluefield.com/fitnesscenter

- 703 College Avenue
- Bluefield, WV
- 304-325-5707

Wythe County

Wytheville Parks & Recreation https://rec.wytheville.org/

- 333 Community Blvd
- Wytheville, VA
- 276-223-3378

City of Radford

Radford Senior Center https://www.radfordva.gov/359/Seniors

- 200 George Street
- Radford, VA
- 540-731-3633

City of Salem

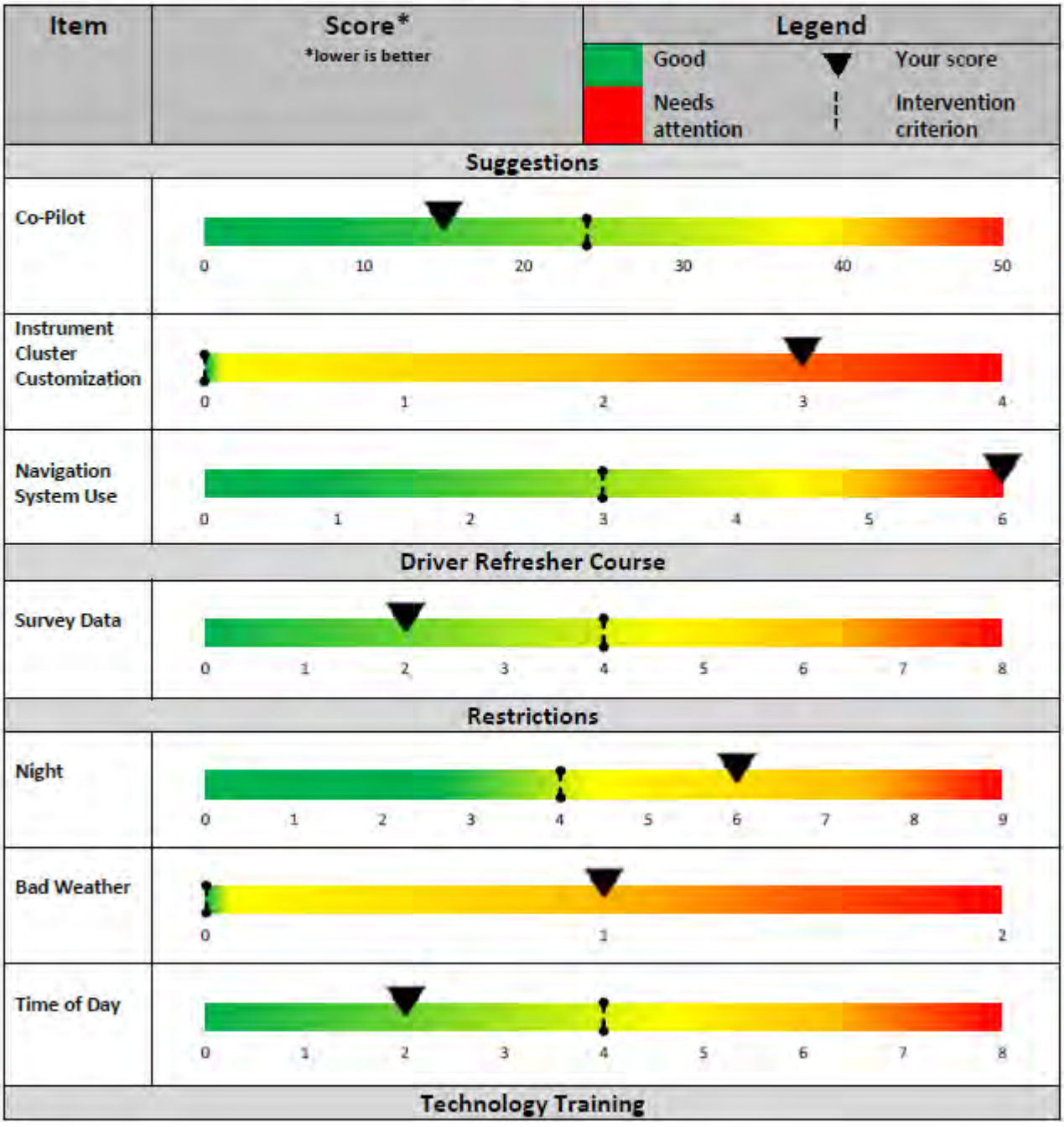
Salem Senior Center https://salemva.gov/Departments/Parks-and-Recreation/Senior-Center

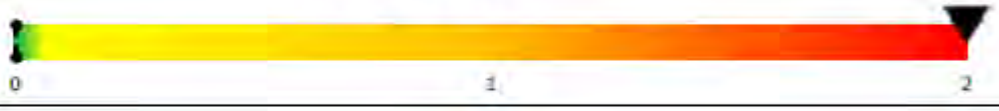
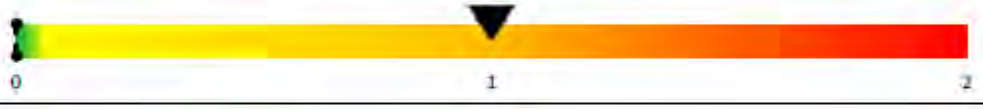
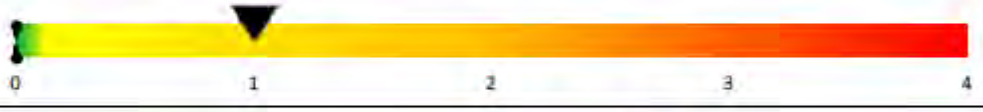
- 110 Union Street
- Salem, VA
- 540-375-3054

APPENDIX E – SAMPLE PARTICIPANT OUTPUT

VIRGINIA TECH TRANSPORTATION INSTITUTE
VIRGINIA TECH

Driving Mobility Information Sheet - XXX

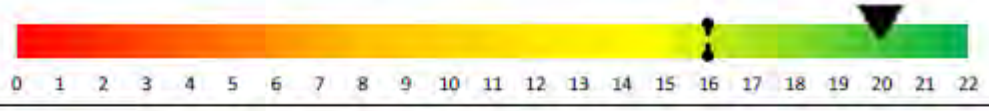
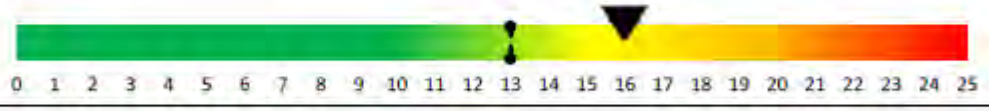
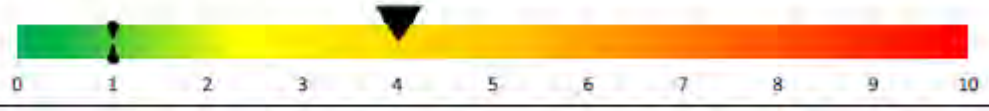
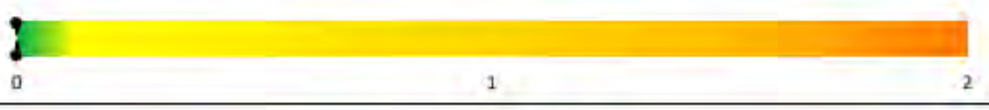


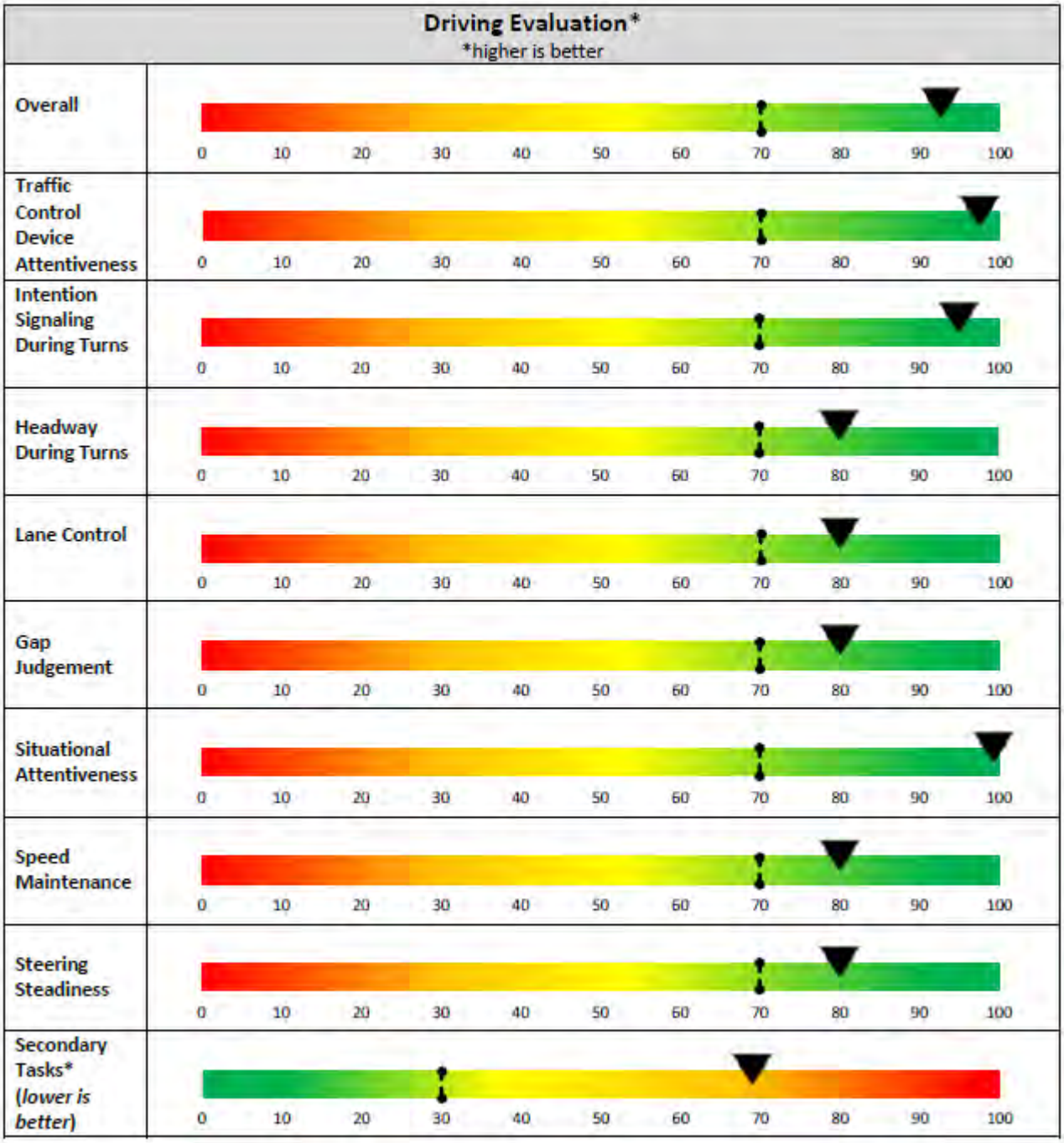
Grocery or Meal Delivery	
Navigation System	
Telehealth	
Route Changes	
Heavy Traffic	
Highways or Interstates	
Gaps and Unprotected Left Turns	
Intersections	
Problem Locations	
Intersections	all 3 exits from my neighborhood onto 460 - median is (or seems) too small, so... either have to negotiate both sides of the highway at once or camp in this no-man's zone
Roadways	all 3 exits from my neighborhood onto 460 - median is (or seems) too small, so... either have to negotiate both sides of the highway at once or camp in this no-man's zone
Merging Locations	None noted
Other	None noted

Common Destinations
Kroger on south main Walmart in Christiansburg Walmart in Pearisburg the weight club .

Alternative Transportation Training	
Ride Share	
Public Bus	
ADA or Paratransit	

ADAS Training
Blind Spot Intervention

Medical	
Medication Review	
Cognitive* (**higher is better*)	
Neuropathy	
Sleep Doctor	
Audiologist	
Optometrist	
Physical Therapist	
Counselor	
Nutritionist	
Occupational Therapist or Driver Rehab.	


Driving Evaluation*
*higher is better
Overall
Traffic Control Device Attentiveness
Intention Signaling During Turns
Headway During Turns
Lane Control
Gap Judgement
Situational Attentiveness
Speed Maintenance
Steering Steadiness
Secondary Tasks* (lower is better)
0 10 20 30 40 50 60 70 80 90 100

Intervention Plan

Suggestions	Driver Refresher Course
• Instrument cluster configuration	**Survey Data** • None noted
	Driving Data • None noted

Medical Suggestions	Training
• Sleep Doctor • Nutritionist	• Blind Spot Intervention

Route Changes and Restrictions	Locations to Review
• Heavy Traffic	Problem Locations • all 3 exits from my neighborhood onto 460 - Median is (or seems) too small, so... either have to negotiate both sides of the highway at once or camp in this no-man's zone • all 3 exits from my neighborhood onto 460 - median is (or seems) too small, so... either have to negotiate both sides of the highway at once or camp in this no-man's zone
	Common Destinations • Kroger on south main • Walmart in Christiansburg • Walmart in Pearisburg • the Weight Club •

Items for Further Discussion
• Blind spot intervention (BSI)

Glossary of Terms

Adaptive cruise control (ACC): With ACC you can set your car to maintain a particular speed, just as with traditional cruise control; however, unlike traditional cruise control, ACC will decrease your car's speed when a leading vehicle slows. Advanced versions (AACC) can even slow and stop your car in traffic jams, then accelerate for you once you have passed the traffic problem.

ADA or paratransit: Transportation designed and designated specifically for people with disabilities that provides individualized rides without fixed routes or timetables

Audiologist: Audiologists are health care professionals who identify, assess, and manage disorders of hearing, balance, and other neural systems.

Automatic emergency braking (AEB): This feature may typically be paired with a feature called forward collision warning (FCW) which scans the road ahead while you drive, warning you if you're about to crash into a car. If you don't react to the FCW in time, AEB quickly slows your car or can even bring it to a rapid stop.

Backup camera: When your car is in Reverse, the back-up camera displays what is behind your car. In most cars the display is located on the center console; in other cars it can be embedded in the rearview mirror or even in the sun visor.

Blind spot intervention (BSI): BSI actively directs the car away from adjacent traffic if you attempt to move into it.

Blind spot warning (BSW): BSW warns you if a car is in your left or right blind spot. Visible warnings typically appear in sideview mirrors or in other nearby locations.

Co-Pilot: A passenger who can assist with driving related tasks such as navigation, adjusting the radio and temperature controls as well as help to scan for threats in the driving environment

Cognitive: relating to mental activities such as thinking, understanding, learning, and remembering

Counselor: Professional who helps clients in a variety of ways: (1) identify goals and potential solutions to problems which cause emotional turmoil; (2) seek to improve communication and coping skills; (3) strengthen self-esteem; and (4) promote behavior change and optimal mental health

Driver rehabilitation specialist (DRS): A professional who plans, develops, coordinates, and implements driver rehabilitation services for individuals with disabilities. This professional has specialized training, experience, and credentials in driver rehabilitation services, including evaluating and training people with disabilities in driving or safe transportation

Lane centering (LC): LC automatically and continuously applies steering inputs to keep the car centered within its lane

Lane departure warning (LDW): LDW alerts driver when lane line is crossed

Lane keeping assist (LKA): LKA applies gentle steering inputs which help to prevent lane departures

Instrument cluster (IC): IC is another term for dashboard, though the modern IC may optionally display much more information than was available on a traditional dashboard

Navigation system: Navigation or GPS systems are sometimes built into the can's display system, but they can also be a separate device mounted onto the dashboard, or it may be an app on a smart phone. Either way, a GPS continuously updates the car's current position on a displayed map of the roadway system. Such systems can also provide visual and/or audible route guidance when a destination is entered

Neuropathy: Neuropathy is damage, disease, or dysfunction of one or more nerves especially of the peripheral nervous system that is typically marked by burning or shooting pain, numbness, tingling, or muscle weakness or atrophy, is often degenerative, and is usually caused by injury, infection, disease, drugs, toxins, or vitamin deficiency

Nutritionist: Registered dietitian nutritionists (RDNs) are food and nutrition experts. They evaluate a person's health and nutritional needs and come up with plans to meet those needs. RDNs help healthcare providers by providing a patient treatment plan.

Occupational therapist (OT): OTs help patients participate in meaningful daily activities and practice habits they may need for work and recreation. The team of occupational therapists works with adults and children recovering from injury and surgery, and those managing chronic illness, to help them care for themselves and be independent.

Optometrist: Optometrists are healthcare professionals who provide primary vision care ranging from sight testing and correction to the diagnosis, treatment, and management of vision changes.

Physical therapist (PT): PT focuses on the evaluation, management, and prevention of disorders of human motion resulting from injury, disease, overuse of muscles or tendons, pain, or loss of a body part.

Rear cross traffic alert (RCTA): RCTA is designed to warn you of cars that are entering your backing path which may be outside of your vision.

Rear emergency braking: Rear automatic braking automatically applies the brakes if a crash is imminent during backing.

Ride-share: A ridesharing company (also known as a transportation network company or ride-hailing service); matches passengers with drivers of vehicles for hire that, unlike taxicabs, cannot legally be hailed from the street. Matching of drivers with riders is accomplished via an integrated smart phone app.

Sleep doctor: A sleep doctor is a health professional specialist who addresses issues relating to sleep, sleep disorders and sleep health. A sleep doctor may be a sleep physician or a sleep psychologist. Each type of sleep specialist deals with different aspects of sleep health.

Telehealth: Telehealth is health care provided remotely to a patient in a separate location using two-way voice and visual communication (as by computer or cell phone).

APPENDIX F – SPOTCHECK CONTRAST SENSITIVITY INSTRUCTION AND SCORING

SpotChecks™ Contrast Sensitivity Test Instructions

(SpotChecks™ is an improved version of CamBlobs™)

Marking the Chart

1) The chart should be placed on a white background (on top of another chart will do) and mounted on a backing that makes it easy to hold it in the hand. Mounting the chart on a regular clipboard is a good solution.

2) The chart should be uniformly illuminated to a level that would be appropriate for easy and comfortable reading (any level of illumination greater than about 200 lux is acceptable). There should be no visible shadows on the chart.

3) If the subject uses reading or other glasses to read, these must be worn when marking the chart.

4) The subject should hold the chart at a comfortable distance in any way that is good for viewing and convenient for marking the chart.

5) The subject should start at the top (or optionally at some lower level at which the spots are still all clearly visible) to mark with a small cross or "X" each of the grey spots that can be seen. A fibre-tip pen is probably the best kind of writing implement to use, but any pen or pencil that reliably produces a clear mark will do.

6) There is a single spot in each of the 5 rectangles on every line and it is important that one grey spot is marked in each rectangle on a line.

7) The subject will probably find that it takes some time (several seconds, maybe as long as 10 seconds) for the fainter spots to appear. Subjects should wait this long, but not longer, to complete marking the spots on the lower lines. Subjects may also find that moving the chart helps to make the fainter spots appear. This is completely acceptable.

8) Subjects should progressively mark the spots down to a level at which they can no longer see the spots even when they have waited for a few seconds. Subjects should then mark one complete line in which they see no spots and have to guess where they are.

Scoring the Marked Chart

9) Use the appropriate translucent scoring template (the letter at the top left of the template should correspond with the letter in that position on the chart) to see which spots have been correctly located and which have not.

10) Reading in the normal way from where the subject started to mark the spots, look for the second incorrectly marked spot. The contrast of this spot can be taken to indicate the subject's contrast threshold. If this spot is the first on a line then the subject's logCS is the value that is printed in the left margin of that line. If the second incorrectly located spot is the second on a line then the subject's logCS is that value + 0.01. Add another 0.01 for each second-error position further along the line.

Notes

The logCS levels of the spots in the first rectangle of each line on the standard SpotChecks™ chart range from 0.90 to 2.05. [logCS = -log(C), where C is the Weber contrast of the spots expressed as a percentage]. The logCS value for each successive spot on any line is greater by 0.01 than that for its left-hand neighbour, making the logCS value for the last (extreme right-hand) spot 0.04 greater than the value in the left-hand margin.

The measurable range of logCS (0.90 to 2.09) should be sufficient for measuring monocularly the contrast sensitivity of normal and mildly visually impaired individuals. However, with binocular vision some individuals may be able to identify the location of all the spots on the chart. In this case their logCS must be recorded simply as "greater than, 2.10".

A version of the chart that covers the logCS range from 0.05 to 1.29 can be provided for measuring the contrast sensitivity of individuals with greater visual impairment.

APPENDIX G – DETAILED INTERVENTION DISTRIBUTION

Intervention	Participants Receiving Intervention	
	n	%
CarFit	10	100%
Restriction or routing change	9	90%
Suggest navigation system use	2	20%
Instrument cluster customization	1	10%
Driver refresh course	1	10%
Navigation system training	1	10%
Suggest telehealth/grocery delivery	1	10%
ADAS training		
Backup camera	4	50%
Training		
Phone pairing/Android Auto/Apple CarPlay	3	33%
Ride-share	1	10%
Health Provider referrals		
Physical therapist	4	40%
Counselor	2	20%
Audiologist	2	20%
Neurologist	1	10%
Discussions		
Secondary tasks	6	60%
Prior crash	3	33%

Seat belt use	3	33%
Neuropathy	3	33%
Car technologies	3	33%
Situational awareness	2	20%
Full stop at intersections	2	20%
Inclement weather	2	20%
Steering steadiness	2	20%
Slowing/stopping in roadway	2	20%
Sleep apnea/Drowsiness	2	20%
Turn signal use	1	10%
Pull-off locations	1	10%
Defensive driving	1	10%
Roundabouts	1	10%
Dangerous maneuvers	1	10%
Night driving	1	10%
Mailbox relocation	1	10%

A brief overview is presented of the resultant discussions related to the interventions received. As above, not every participant received every intervention, so the resulting sample size is noted for interventions. Those which were only received by a single participant are not presented for brevity.

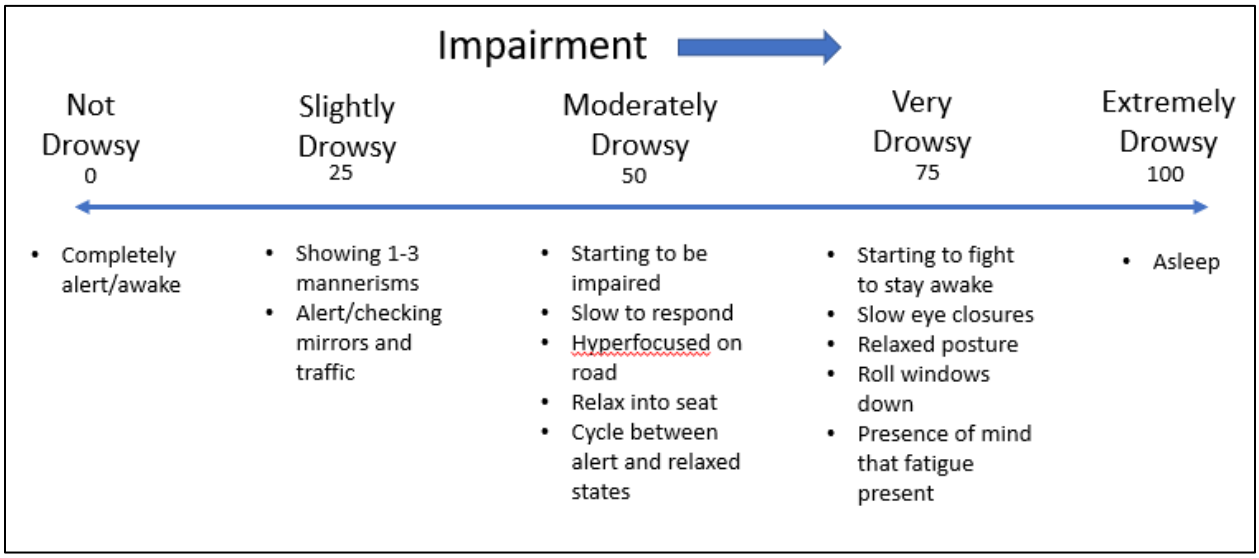
- **CarFit (n=10)**
  - 10 stated improved safety and or confidence (7 mirror adjustments, 5 steering wheel/seat adjustments)
- **Alternative Route Suggestion (n=9)**
  - 2 liked the proposed alternative routes
  - 3 had not yet tried the proposed routes
  - 3 were already aware of the suggestions
  - 1 plans on using the route once mobility declines further
- **Secondary Task Engagement Discussion (n=6)**
  - 5 said the conversation was helpful to refocus on driving
  - 1 did not believe they engaged in secondary tasks and dismissed the conversation
- **Backup Camera Training (n=4)**
  - 4 stated they use the backup camera more now and the demonstration was valuable in highlighting field-of-view benefits of a camera system
- **Phone Pairing/Android Auto/Apple CarPlay (n=3)**
  - 2 stated they felt safer after phone pairing

    - 1 stated they did not use the manufacturer's system due to the cost associated
- **Prior Crash Discussion (n=3)**
    - 3 stated the discussion helped to better understand what happened and how to help mitigate another incident
    - 2 believe a conversation with a counselor may be helpful but have not pursued
- **Seat Belt Use Discussion (n=3)**
    - 3 state they are more aware of belt use
- **Neuropathy Discussion (n=3)**
    - 3 state the information was good for future use but not currently applicable
- **Discussion of Vehicle Technologies (n=3)**
    - 1 found the conversation useful to determine what features are needed in a new vehicle purchase
    - 1 found the conversation helpful to better understand the feature
    - 1 did not find the conversation beneficial
- **Physical Therapist Suggestion (n=4)**
    - 3 believe it would be beneficial but had not pursued it at the time of the exit interview
    - 1 has initiated a conversation with their provider
- **Audiologist (n=2)**
    - 1 felt it worthwhile to initiate a conversation with their provider but had not done so at the time of the exit interview
    - 1 is still considering an audiologist but has not pursued
- **Situational Awareness Discussion (n=2)**
    - 2 stated they are checking their mirrors more often and are gaining more situational awareness as a result
- **Full-Stop at Intersection Discussion (n=2)**
    - 1 stated they are more aware of stopping
    - 1 stated they believe safety is not an issue with not fully stopping
- **Inclement Weather Discussion (n=2)**
    - 2 stated the discussion was not helpful as the information was already known
- **Steering Steadiness (n=2)**
    - 1 stated it helped to improve safety by serving as a reminder to attend to the driving task
    - 1 stated it was not an issue or relevant – that it may be corrections against the lane-centering system
- **Slowing/Stopping in Roadway (n=2)**
    - 1 stated the conversation was not beneficial as it was a rural area with low traffic; however, he did note increased situational awareness related to surrounding traffic as a result
- **Navigation System Use Suggestion (n=2)**
    - 1 stated they now use a navigation system to support driving out of town
    - 1 did not choose to pursue navigation system use due to the cost associated with the proprietary vehicle interface
- **Sleep apnea/drowsiness (n=2)**
    - 2 stated they are aware of their level of drowsiness more

APPENDIX H – NATURALISTIC DATA SAMPLING METHODOLOGY

To evaluate the effect of the consultation session on the large amount of collected naturalistic data was untenable, so a process was created to sample the data. The methods utilized to evaluate pre- and post-consultation behaviors are presented below.

- **Secondary tasks.** To get an overall impression of secondary task engagement, the researchers randomly selected 10% of epochs 30 seconds or longer in duration. Tasks were coded based on the SHRP 2 methodology used by Owens and colleagues (2015).
- **Observer Rating of Drowsiness (ORD).** A total of 50 events were randomly selected for ORD, evenly divided between pre- and post-consultation, and an equal distribution of day and night events between the phases. These events were 30 seconds in length and the drowsiness rating was based solely on what was evident in that video segment. The protocol for assessing events was adapted from Wiegand and colleagues (2009), where each analyst recorded their score independently from 1 to 100 and blinded from one another (Weigand et al., 2009). Following scoring, any instance of values differing by 20 or more points was subject to review and discussion. If the scores could not be brought within that tolerance, a third independent reviewer was consulted. Finally, scores were averaged for data analysis.



- **Situational awareness.** To evaluate a driver's situational awareness during straight segments of roadway, two locations were identified in the video data to locate suitable locations. The GPS coordinates were then applied to search for all trips in which the driver passed through those points. Of the resultant sample, 15 events before and after the consultation were selected for analysis.
- **Alternative routes.** Determining the use of alternative route suggestions or behaviors (such as using a pull-off location) was completed by using GPS coordinates of a location to search trip files for the use of that alternative. In the case of pull-off locations, those trips were then subject to viewing to determine if a pull-off was used at all.
- **Intersection signal attention.** Two types of intersections were evaluated: signalized and stop sign-controlled. In the case of both, researchers scanned video of drives to locate intersections in a random 10% of trip video files both pre- and post-consultation.

- **Intersection turn signal use.** Using the intersections identified above, the researchers coded turn signal use. Determinations between late and appropriate use were determined subjectively based on distance from the intersection and speed.
- **Backing.** Researchers scanned a random 25% of trip video files for backing events.
- **Lane choice.** For lane choice evaluations, the researchers utilized GPS data (like alternative routes above) to scan the datastream for trips through a given location. A total of 15 events were randomly selected from each before and after the consultation for analyses.
- **Seat belt use.** In cases where seat belt use was to be evaluated, the researchers attempted to identify use before vehicle movement. However, due to the lag time in the DAS bootup, participants were already driving by the time the video began collecting. If the seat belt was fastened, it was indeterminable whether the participant did so before moving or not. As a result, this analysis was not utilized.

APPENDIX I – CASE STUDY HIGHLIGHTS

1184

Overview

Participant 1184 is a 73-year-old woman driving a 2016 Dodge Pro Master van. She enrolled in the study due to a lack of driving confidence resulting from a prior crash in 2015, as well as to improve her driving skills, which may have diminished over time. Her spouse operated as a stakeholder in the process for her and was regularly engaged.

Highlights

A roadway she frequently travels is a narrow two-lane road with tight turns and many elevation changes, which results in poor sight distance and much slowing for corners. While the speed limit is 55 mph on this road, it is often necessary to slow to well below that limit to comfortably navigate the terrain. As a result, she felt pressure from following traffic to "drive at the limit," which caused her stress. The researchers discussed defensive driving techniques and how to remain focused on her safety, as well as identified several pull-off locations she could use if traffic began to build up behind her. In the naturalistic data collection, naturalistic data showed her utilizing pull-off locations to allow following traffic to pass.

The participant noted during her intake questionnaire that she experienced a prior crash, but it was not until the consultation session that the researchers were aware of the severity of the impact. The crash was a result of a blind lane change after a series of days with very little sleep. As a result, she now experienced anxiety surrounding adjacent vehicles. The researchers also spoke about situational awareness in the form of mirror checks while driving. Naturalistic reduction showed an increase in the rate of review mirror glances from 0.33 per 30-second segment to 1.07 per segment. The rate of side mirror checks did not appreciably change (1.27 glances per segment to 1.33 glances per segment).

It was revealed from the consultation that her partner and copilot may be a significant source of driving stress. Given the delicate social nature, the researchers did not engage in any discussion surrounding negative copilot behaviors. Participant 1184 stated that her involvement in this program was "just what she needed."

1228

Overview

Participant 1228 is a 73-year-old male who drives a 2015 Subaru Forester. He enrolled in the study because he felt that his driving skills were degrading.

Highlights

This participant expressed anxiety and fear about a left-merge on-ramp located in a nearby moderate-sized city. The on-ramp requires the driver to join a typically highly dense flow of traffic traveling 65 to 70 mph. As a merge from the left side is less common, he did not feel very confident doing so. The researchers noted an alternative route that allowed a typical merge from the right side and only extended his trip by a couple of minutes. He responded that he was "elated" and "very happy to have found this option." During the study, no evidence emerged that he actively used the alternative route; however, it is located out of town, and he may not have been required to travel to that location during the study period.

Additionally, the researchers noticed evidence of drowsiness while driving, which led to a conversation about sleep apnea. The conversation focused on the dangers of drowsy driving and allocating attention to the information provided by his continuous positive airway pressure (CPAP) machine. During the exit session, he spoke about paying attention to his machine and therefore informing his quality of sleep the night before. Naturalistic analyses showed no meaningful difference in his average ORD scores (Pre: 28.6, Post: 34.0), suggesting 1228's attention to the CPAP output has not impacted his willingness to drive when drowsy.

1253

Overview

Participant 1253 is an 80-year-old male who drives a 2012 Toyota Highlander. He enrolled in the study for educational and recreational purposes; he did not have a specific incident or feel that his driving skills were in decline.

Highlights

This participant received training on how to use his rear-vision camera during the consultation session. While his vehicle was equipped with one, it was small (only 2.5 to 3.0 inches in diameter), and he felt it was of little to no use. The training session impressed upon him the importance of visibility directly behind the rear bumper, a location not visible with mirrors. The naturalistic data analyses showed a modest increase in rear camera use during backing maneuvers (Pre: 6.7%, Post: 12.9%).

The researchers also engaged in discussions with 1253 about failing to come to a complete stop at intersections and engagement in secondary tasks. Data analyses showed a minor change in complete stops at stop signs (Pre: 20% stops, Post: 30% stops). At the exit session, the participant stated that he felt his attention was already allocated in the correct locations and a full stop was not warranted. Similarly, he believed his engagement in secondary tasks (flossing with a device in particular) did not impair his driving abilities. This was reflected in the naturalistic data analysis, which showed no meaningful change in secondary task engagement (Pre: 1.9 tasks per segment, Post: 2.0 tasks per segment).

1257

Overview

Participant 1257 is a 68-year-old female who drives a 2017 Jeep Cherokee. She volunteered for the research project because she felt like it was an important research topic to explore and wanted to be of assistance. She did not note any specific incidents or declines in driving skills, though it was later identified that she experienced driving anxiety related to a prior crash.

Highlights

This participant received backup camera training during the consultation session. Data analyses showed increased use of her rear vision system during backing maneuvers after the consultation session (Pre: 20%, Post: 40% of backing maneuvers). Additionally, the researchers noticed phone use for navigation. Before interacting with the researchers, she would lay the phone on her leg or hold it in her left hand while driving. During the consultation session, the researchers explored the use of her vehicle's built-in navigation system as well as a phone holder. Both

options would eliminate the need to physically hold the phone. At the exit session, the participant noted purchasing a phone mount for use in her vehicle.

1452

Overview

Participant 1452 is an 84-year-old female who drives a 2010 Subaru Forester. Her vehicle has no ADAS features. She volunteered for the research study because she enjoyed prior participation and felt that she could provide a benefit to other older adults by participating. She expressed dissatisfaction with the installation time required for the naturalistic data collection equipment in her vehicle.

Highlights

Naturalistic data evaluation revealed an unsafe backing maneuver. When returning to her home, she would stop in the middle of the roadway to initiate backing *against* the flow of traffic and into her driveway. She felt this was the safest way to enter her driveway, even in the absence of seat belt use. Researchers identified two alternative maneuvers that were safer: the use of her neighbor's connected driveway to allow her to pull into hers and reorient her vehicle accordingly, and building out additional space on her driveway that would also allow her to avoid backing along the roadway. The participant was not willing to consider the use of her neighbor's driveway but did entertain the idea of building out her driveway to accommodate turning around. However, at the outset of the study, she indicated she did not pursue the build-out option because she felt safe continuing to back as she had done previously. Naturalistic analyses revealed that 1452 continued to back into her driveway against the flow of traffic.

1453

Overview

Participant 1453 is a 67-year-old woman who drives a 2011 Lexus RX with only a backup camera as an advanced feature. She was involved in a prior crash more than 10 years ago. She enrolled in the program to validate her perception of her driving safety and wanted to help further research in this area.

Highlights

This participant reported a dramatic improvement in her driving position after the CarFit session. She no longer experienced cramps in her foot or shoulder pain from the repositioning. The participant stated, "I can't tell you what a difference it made." Additionally, she expressed a new level of confidence from the improved visibility and situational awareness the mirror adjustments afforded her, saying the improvement is "really obvious." Additionally, she typically avoided the use of her backup camera due to its small size (2.5 to 3.0 inches in diameter, located in her rearview mirror), but following the consultation noted using the camera as the demonstration was particularly helpful in highlighting the additional visibility afforded by the camera. A review of driving data showed an increase in rear camera use (pre: 67% of backing events, post: 89% of backing events). Note that given the location of her rear camera display, glances to the rear camera were indistinguishable from glances to the rearview mirror and, for this analysis, all glances to the rearview mirror were considered to the rear camera display.

1461

Overview

The participant is a 71-year-old female who drives a 2019 Mitsubishi Mirage with a backup camera and CarPlay/Android Auto connectivity. Participant 1461 was involved in a crash on a major highway less than 5 years ago. She enrolled in the program to increase her driving confidence and wanted individual attention to improve her driving safety.

Highlights

This participant did not use her backup camera often as she felt her visibility was good enough; following the consultation where a demonstration was provided about the backup camera field of view, the participant has now noted using the camera, saying "it made a big difference" and "the demonstration was very helpful." She was unaware of the extent to which using only her mirrors and over-the-shoulder glances was impeding her visibility of objects directly behind the vehicle. She also regularly engaged in phone calls and navigation while holding her phone in her hand or lap. The consultation provided her with both a connection to Bluetooth, as well as a connection for Android Auto, to allow for phone calls to be routed through the car and navigation to be presented on the central display. She was unaware that technology existed, let alone that she had access to it in her vehicle. During her exit interview, she stated that she "had no idea that sort of technology existed, it's so helpful." She also stated that the CarFit session made her "more confident to drive" as she now has better visibility around the vehicle. A review of the naturalistic driving data showed no change in rear camera utilization during backing maneuvers (pre: 66.7%, post 63.6% of backing maneuvers).

1463

Overview

Participant 1463 is a 69-year-old male who drives a 2013 Honda CR-V with a backup camera and enrolled in the program because he felt his participation would help the program and therefore other drivers. He did not feel as though his driving needed any particular attention.

Highlights

The main finding for this individual came from a review of his naturalistic driving data. He often stopped his vehicle in the middle of the oncoming lane and exited to retrieve his mail. Unfortunately, this location occurs directly after a blind corner, raising the associated risk. The researchers proposed the idea of moving his mailbox to a safer location; one alongside his driveway was suggested, in addition to contacting his local postmaster. At the time of the study exit, the participant had not yet contacted his postmaster as he believed she would be unable or unwilling to facilitate the process. VTTI reached out to the postmaster seeking additional information but did not receive a response. This participant was given alternative routing for out-of-town trips to avoid the high speeds and stress of the local interstate. He followed the alternative routing, which included lower speeds, but more traffic lights and potential sources of conflict. He stated he was aware of the benefits and potential drawbacks of the alternative route but found it less stressful overall than the interstate. Participant 1463 stated that his participation "gave me a lot more confidence," and that it was "real helpful – I wish more people could go through this program."

1465

Overview

Participant 1465 is a 76-year-old male driving a 2007 Subaru Baja with no ADAS features. He took part in this study partially because he wanted to do something that may help others and partially to learn about himself and his driving.

Highlights

This participant engaged in several discussions, including on drowsiness and fatigue, engagement in secondary tasks, a referral to an audiologist, and a referral to a physical therapist. His naturalistic driving data revealed a couple of instances of what appeared to be high levels of fatigue and frequent engagement in secondary tasks.

Following the consultation, he noted increased awareness of his fatigue. He stated he is now more willing to switch drivers when needed and noted he is more likely to engage in snacking to ward off drowsiness. Naturalistic data analyses showed no change in his ORD scores, potentially due to the overall low magnitude of drowsiness present. After the consultation session, the participant noted significantly increased awareness of such tasks, and the naturalistic analyses revealed an *increase* in the rate of secondary task engagement (1.7 tasks per segment to 2.8 tasks per segment). He did note during his exit interview that he willingly continues to engage in secondary tasks but is aware of the increased risk.

Additionally, his surveys revealed a level of hearing difficulty that permeated his life and greatly affected his perception of well-being. The researchers discovered a couple of unsuccessful attempts at hearing aids, which ultimately failed due in part to an unwillingness to work with an audiologist to adjust the aids correctly. Unfortunately, at the time of the study exit, he had not pursued an audiologist, though he was still considering it. Participant 1465 experienced pain in his knee due to a loss of cartilage but had not yet sought out any supplemental medical advice that may help to alleviate or better manage the pain, such as from a physical therapist to strengthen the surrounding musculature. Following the consultation, he sought out his chiropractor to discuss options. He has initiated a strengthening program for the surrounding musculature to better stabilize the knee and reduce pain.

1466

Overview

Participant 1466 is a 67-year-old male who drives a 2022 Toyota Rav 4 with L2 ADAS features. He enrolled in the program because of his former experience as a researcher and wanted to provide data for the program.

Highlights

This participant's experience mainly focused on discussions related to his slowing and stopping in the middle of the roadway and suggestions for maneuvering downtown when pedestrian traffic was high. A review of his naturalistic driving data showed he sometimes stopped in the middle of the roadway to look at wildlife. While he lives in a rural area with little traffic, a discussion surrounding situational awareness occurred. Following the consultation, he states that he still stops, but that he's more aware of any traffic behind him. He also spoke of difficulty driving in the downtown areas, especially when college students were out. A simple alternative route taking him off the main roadway was suggested. At the time of the study exit, he had not yet tried the

additional routing but stated that it was a good idea. He was also trained to use ride-share services and provided suggestions that may prove helpful such as parking nearby and then using ride-share to his destination through the most difficult areas. He believed the ride-share to be a helpful option for the future, but not yet one he required at this time. Even though many of the discussions surrounding 1466's driving did not feel urgent to the participant, he did state that it was "very easy and useful" and that it "opens eyes for discussion."

APPENDIX J – TEST ROUTE SCORING PROTOCOL

Summary Judgments	Rate the driver's level of safety on the following maneuvers/scenarios based on the scale below:						Demerits
Intersection Device Attentiveness • Full stops on reds/ signs, right of way, turn signals	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Lane Position • cross center line, lane busts	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Following Distance • Comfortable or too close	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Situational Awareness • Glances to mirrors, threat locations	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Appropriate Speed • With flow of traffic or within ~5 mph of limit	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Driving Aggressiveness/Soundness • Braking, cornering, lane changes	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Crosswalks • Yielding, glances to pedestrians	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Backing Glances/Mirror/Camera Use • Glances to mirrors, OTS, backup camera	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
LTAP Gap Judgement • Comfortable distance, no evasive maneuvers	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Merge • Signal, mirror checks, get up to speed	**Very Unsafe**	**Somewhat Unsafe**	**Neutral**	**Somewhat Safe**	**Very Safe**	**NA**	
Comments							

How familiar were you with this route before today?
Not at all Somewhat unfamiliar Neutral Somewhat familiar Very familiar