mobile SIMULATOR TRIAL

Encouraging safe mobility in older drivers through mobile screening

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Executive Summary

The UK population is ageing, as it is across the industrialised world, and an ageing population will create new demands if they are to continue to contribute to society and to lead independent, fulfilled lives. Mobility in later life is a vital aspect of maintaining health, wellbeing, and civic contribution. One effect of the ageing population is the rapid growth in the number of older driving licence holders, resulting in a growing number of older people who are featuring in the road casualty data (due to their increased fragility and greater exposure from driving for longer). Understanding when older people are not fit to drive anymore and directing them to feasible alternatives is an important element of reducing this increasing risk.

The range of interventions targeting this topic is wide, with a lot of them being local schemes; some newer and driven by clinical research and findings; and some outdated and weak in demonstrating effectiveness, operability, suitability, or acceptability. According to experts' opinion, new developments in mobile simulators technology allow for the development of a suitable, acceptable, feasible, replicable, and sustainable older driver fitness to drive mobile screening programme. This study aims to investigate the meaningfulness of the test results and the feasibility and acceptability of such a programme.

A pilot and small trial were conducted in October 2020 in Banbury, Oxfordshire to assess the acceptability and accessibility of mobile simulator screening for driver fitness assessment, with the following specific objectives:

- To assess if the simulator tests provided a meaningful assessment of abilities which impact on collision risk.
- To assess if simulator tests were feasible to deliver.
- To assess if the simulator tests were more acceptable to clinicians than traditional assessment methods.
- To assess if the simulator tests were acceptable to older drivers, identifying the fears and barriers encountered by older drivers.

This method of simulator use assesses driving performance rather than looking for specific conditions, whilst not excluding behaviour affected by particular diseases or disorders. Therefore, the drivers are screened for their driving behaviour and not for medical conditions, which will allow the identification of behaviours affected by lack of practice, by forgetting driving rules or any other similar reasons. While it will not identify specific conditions, the drivers can be referred for further investigations of possible causes for the outlying behaviour.

A range of data was collected within the sessions. These included information about participants, such as medical conditions and driving history. Participants were observed in the simulator and many provided feedback on the experience. A wealth of data was collected per participant from the simulator itself, with four specific scenarios tested: a free drive; an emergency braking task; a daytime scenario featuring two junctions and a number of hazards; and the same scenario in a night-time environment.

The pilot was designed to test the simulator scenarios and delivery mechanisms, with minor adaptations implemented before proceeding to a trial. Elements measured by the simulator included average, maximum and 85th percentile speeds, braking times, indicator and horn use times and session durations. These were analysed for the ten pilot participants and 66 programme participants, with the intention of determining normal distributions and identifying outlier participants whose measures were outside these normal distributions. Observations of simulator driving behaviour of participants were recorded and compared with the objective data from the simulator itself. Many of those identified as outliers by the data were observed to be overconfident, underconfident, hesitant or drove with high variability in their chosen speed. Most of the outlier participants reported suffering medical conditions and many of these conditions are known to impair driving performance (COPD, rheumatoid arthritis, sleep apnea, diabetes, cataracts, stoke, vertigo and asthma). The presence of these conditions amongst the outlier participants indicates that the simulator is able to detect differences in driving performance related to health. In practice, these outliers would be referred for further investigation.

The study encountered a number of limitations. The COVID19 pandemic necessitated a move away from using NHS and GPs' surgeries to renting a pop-up shop in a shopping centre. This changed the recruitment methodology from referral of those with medical conditions and potential GP concerns about driving to self-selection of participants. This is likely to have changed the driving performance levels of participants, although the results showed a meaningful distribution of performance which allowed for the defining of outlying behaviours. Health practitioners were not contactable at the time, given their priorities of dealing with the pandemic. This manifested as an inability to work with GPs and healthcare practitioners on delivery as well as undertaking the accessibility, acceptance, and feasibility interviews and focus groups. Understanding their willingness to embrace a simulator-based approach as a triaging tool will be critical in any future development of the approach.

There were other limitations related to the available scenarios used in the simulator and the data which could be captured. The existing scenarios were created to train professional drivers and are therefore more complex than might be required for this project. The measures which could be captured were also predefined and the creation of additional measurements, such as swerving actions, would be useful. The sample size of a total of 76 participants was sufficient to test the concept of using a simulator to identify drivers for referral but a larger sample size would allow data to be sliced in more ways.

However, there were a number of strengths identified in the study. It showed that the method is not only feasible but also meaningful, exhibiting results in line with the observations taken by the team members during the simulator assessments. The tool could allow for a better selection of drivers to be referred to further investigation, increasing the efficiency of referrals to assessment and giving the opportunity of a quick screening that would overcome practitioners and GPs' own specialism biases or reticence to refer.

In terms of opportunities, the technology around simulators and their capabilities is seeing a rapid development, allowing not only for more comprehensive and realistic simulations, but also for more affordable solutions for deployment, where necessary (GP practices, public spaces, etc.). The development of an affordable solution will allow for an initial screening which will reduce the number of unnecessary assessments, and therefore increase the efficiency of the practitioners.

The project had been successful in identifying different levels of driving behaviour in older drivers. Identifying most of the participants with relevant observations on the observational sheet in the data analysis, either as outliers (5%) or with missing data, is a very encouraging result as it confirms that the tool has the potential to flag significantly different behaviour.

The participants accepted the simulator as an assessment tool and easily became familiar with the environment, requiring, on average, no more than three or four minutes of free drive and just a few clear indications on the similarities and differences from a real car environment. Some of the participants even found the testing more acceptable than a traditional assessment, as they consider it is safer than an on-road assessment; should be easier to reach and book (at GPs' locations or in other specific locations); and gives the opportunity to simulate potential hazards and situations that might not appear in an on-road assessment. Several participants underlined that the difficulty of the simulated environment might be higher than on the roads they regularly drive on, but most saw that as a good thing, as driving is not always happening as planned.

A number of recommendations for future research are made, including conducting a wider experiment to increase the sample size and to deliver the simulator in a primary healthcare setting to include referred participants with medical conditions or driving concerns. The team have made suggestions for improving the included scenarios, to ensure suitability of the tasks and measures for this target audience. It would also strengthen the findings to validate and cross-validate with on-road and medical assessments. Learning points about the delivery mechanism have been shared, with suggested improvements about the time for delivery, staff required and assessment processes.

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Part One: Background

Introduction

By 2036, there will be nearly 17.5m over 65s in the UK, accounting for almost one quarter of the population. Many of them will be working, volunteering, caring, and supporting friends and family, raising questions over maintenance of safe mobility for this burgeoning segment of the population. Greater mobility in later life is associated with beneficial effects on well-being, physical health and the wider community with transport playing a key role in facilitating a greater sense of community belonging for older people.

One effect of the ageing population is the rapid growth in the number of older driving licence holders. Between 1995/97 and 2017 the proportion of the population aged 70+ holding a licence increased from 39.4% to 63.8%. According to the National Travel Survey, drivers over 60 years old are the only age group to increase the average number of trips per year as a car driver and the miles they travel (Department for Transport, 2020). A natural consequence of this increased time on the road is the growing number of older people who are featuring in the road casualty data.

Background and rationale

In 2019, RoadSafe trustee, John Plowman and Road Safety Analysis (RSA) director Dan Campsall, at the request of the Department for Transport, wrote a paper (Campsall & Plowman, 2019) that explored a range of options for developing deliverable programmes to enhance safety for older drivers. There were a wide range of interventions targeting older vulnerable road users at that time, many of which had been set-up to address local concerns, and some had been driven by clinical research priorities. They involved a range of disciplines and sectors in delivery, with differing resource demands and varying levels of direct engagement with the target audience being 'treated'.

The evidence of effectiveness was patchy, with many programmes lacking robust evaluation. For this reason, selecting a small number of viable interventions that could contribute to an overall improvement in safety for Older Vulnerable Road Users presented quite a challenge. As a starting point, the following factors were considered in evaluating which interventions should be taken forward:

- Evidence based
- Allowing for innovation
- Operability, replicability and scalability
- Variety and interdisciplinarity

Among the five most promising intervention programmes the report recommended testing was a 'mobile simulator screening programme'.

Later in 2019, RSA, with support from VTi (the Swedish National Road and Transport Research Institute), produced a wider list of 62 viable interventions (listed in Appendix A: 62 Viable Interventions on page 42) that could have desirable outcomes for older drivers in the UK[1]. These were then independently scored by a team of experienced practitioners and researchers according to the following measures:

- Suitability - Does this intervention address the defined problem and is it likely to have the desired impact on the target audience?

[1] Unpublished report

- Acceptability - Will the target audience buy into this intervention?
- Feasibility - How confident are we that key stakeholders have the resources and capabilities to ensure this is delivered as desired?
- Replicability - Can this intervention be replicated elsewhere or scaled up to be delivered more widely?
- Sustainability - How lasting are the effects of this intervention on the target audience (assuming necessary resources to maintain the intervention)?

The highest ranked intervention for which no current models of delivery exist was a mobile simulator screening assessment for use in primary healthcare settings.

The Older Drivers Task Force recognised that "*GPs have a responsibility towards the wider road user to ensure that drivers who may be unfit to drive are given adequate attention and support*." However, they also noted that "*GPs are busy people and are not trained to assess a patient's driving skills*" and the Road Safety Observatory synthesis identifies the fact that GPs are "*faced with the ethical conundrum of recommending that a patient should cease to drive*". It was identified that protocols were lacking to facilitate conversations between healthcare professionals and older road users and that there is no standard testing protocol to allow objective measurement of physical and cognitive performance as it relates to the driving task (Older Drivers Task Force, 2017).

Research has demonstrated the viability of utilising low cost, portable simulator rigs for testing physical conditions and impairment, and the potential exists to extend this as a mechanism for screening. There is growing confidence that a viable screening assessment could be delivered using such a mechanism and to test this in a UK context. Screening may also highlight medical needs (cognitive and physical) that were otherwise undetected.

This project, delivered in 2020-21, proposed to explore the feasibility of using mobile simulator screening in primary care settings[2] in the UK, seeking to understand the acceptability of such approaches and whether they are deemed to be accessible to the target cohort and their primary care providers, particularly GPs.

Capacity and capability

The Agilysis' project team, together with the appointed Occupational Therapist, and the XPI Simulations technical and development team, worked on the creation of the assessment tool. The delivery of the pilot and the intervention was undertaken by the Occupational Therapist together with a team of two Agilysis staff experienced in intervention delivery.

The Agilysis team has the capability to lead, deliver and oversee pilot design and implementation, from a road safety and behavioural perspective, having accumulated more than a decade of substantial experience in designing, delivering and evaluating interventions for at-risk or vulnerable road users across the entire age spectrum. The appointed Occupational Therapist ensured that all the important elements of the assessment were introduced and delivered. They conducted the observational side of the study, making notes of all the events and elements for consideration.

The XPI Simulation team has extensive expertise in creating tailored simulation scenarios for training and evaluation purposes and have a suite of pre-existing elements which were included and adapted for the project. They ensured that the simulation scenario included the desired elements, and also

[2] For reasons related to the ongoing COVID context, the project team decided to undertake the pilot phase in a controlled environment

that the appropriate metrics were being recorded (such as reaction time, brake strength, and trajectory).

Study aims

The study's aim was to assess the acceptability and accessibility of mobile simulator screening for driver fitness assessment, with the following specific objectives:

- To assess if the simulator tests provided a meaningful assessment of abilities which impact on collision risk.
- To assess if simulator tests were feasible to deliver.
- To assess if the simulator tests were more acceptable to clinicians than traditional assessment methods.
- To assess if the simulator tests were acceptable to older drivers, identifying the fears and barriers encountered by older drivers.

For these objectives to be met, specific measures and tools were developed, based on the findings and the limitations from the pilot study, but also dictated by the scenario design capability and the time limits of delivery.

Current situation

Whilst numerous reports have pointed to the role of primary healthcare providers, and GPs in particular, in identifying changes in driver health or mobility that should be addressed, several constraints on general practice mean this situation is unlikely to change without new tools or interventions. The practical realities of GP care, with high patient demand and complex cases, mean that routine activities such as driving are rarely addressed as a priority. GPs often have to balance a wide range of social and medical considerations as they endeavour to improve patient health and support them in the community and are often understandably unwilling to risk the vital relationships they enjoy with their patients by addressing driving without justifiable cause. Also, as non-specialists in driver safety, and without an established battery of tests to provide good supporting evidence, GPs often do not feel well equipped to address safety concerns with their patients.

Gap analysis

The GAP analysis undertaken is focused on two main topics: (1) Existing tools and mechanisms, and (2) Neurological and psychological tests. The two topics are of crucial importance for the project but also for understanding the current status and capabilities of screening programmes and practice.

Existing tools and mechanisms

This section provides an understanding of the existing mechanisms that practitioners benefit from in terms of assessing and referring drivers for assessment in relation to fitness to drive. A clear mechanism with defined responsibilities and accountability would empower health practitioners to assess or refer people to assessment, supported by external justification and validation. This would allow practitioners to undertake these actions when they feel that a person might be at risk, without fear of upsetting the privileged patient relationship. The existence of reliable and valid tools for assessment would give the practitioners the necessary confidence that the decision they make is the best one, and therefore referring the patient to see a further specialist, or even restricting the right to drive (through referral to the DVLA) is the correct decision. Without such tools, practitioners will only take the decision when the level of risk is highly elevated and obvious. Therefore, both these elements (appropriate mechanisms in place and appropriate valid tools) are mandatory for screening programmes to be successful.

In conclusion, existing tools are, in general, specifically designed for certain conditions and are often reliant on the specialities of the practitioners. Therefore, a more general tool is needed, characterised by ease of use and interpretation of results.

Neurological and psychological tests

A review of the literature identified a multitude of tests and assessments with very high levels of validity in capturing various neurological, physiological, and physical conditions or markers. There are different tools and techniques to assess fitness to drive in people with Parkinson's disease (Devlin, McGillivray, Charlton, Lowndes, & Etienne, 2012) (Devos, Nieuwboer, Vandenberghe, Tant, & de Weerdt, 2013), Alzheimer's disease (Etienne, Marin-Lamellet, & Laurent, 2013) (Piersma, et al., 2016), driving after a stroke (Devos, et al., 2011), driving with cognitive impairments (Kay, Bundy, & Clemson, 2009), or sleep disorders (Schreier et al., 2017).

Asimakopulos (Asimakopulos, et al., 2012) identifies 53 executive function tools to assess fitness to drive, of which 27 were general assessments of cognition, 19 driving-specific and seven activities and instrumental activities of daily living assessments. Asimakopulos highlights the great diversity in the outcomes used to measure fitness to drive, and the lack of a gold-standard outcome measurement for driving performance. A similar conclusion was reached by Dickerson (2014), finding that there are various and multiple assessments with different outcomes to predict driving performance, generally in the areas of cognition, perception, vision, and physical or motor components. Other authors also assess the existing tools and evidence and suggest an assessment approach to include physical, cognitive and visual-perceptual components (Vrkljan, McGrath, & Letts, 2011).

Nevertheless, the major downside of this area comes from, on one hand, the complexity of these tools which makes their application complex, and by their specificity on the other hand. Having an extensive set of very specific and narrow complex assessment tools makes it impractical for a practitioner to use these tools for a general assessment. Health practitioners will need to determine which tool to use, from a selection of the tools (often making a decision based on correlation with their own knowledge). This can make the use of the tool less effective as the practitioner's professional judgement will often be good enough to detect important markers within their area of expertise. The need is actually for tools to cover areas outside of expertise, and if the tools require expert knowledge to be applied or interpreted, then it often deters practitioners from using them. A simple, general but comprehensive tool is needed.

Simulator capabilities

Whilst simulator capabilities have become more comprehensible lately, the subject has been around and under debate for a considerable number of years now. VTI (Harms, 1996) validated driving performance in a driving simulator compared to on-road driving performance over 20 years ago, followed by Lee (2002) (Lee, Cameron, & Lee, 2003) who obtained results to support the validity of driver simulator assessments and suggested the techniques as a more economical and safer alternative to on-road testing for driving performance assessment of older adult drivers. These results were followed by multiple validation studies, all with the same conclusion of the simulator being a valid and reliable alternative to on-road assessments (Bedard, Parkkari, Weaver, Riendeau, & Dahquist, 2010) (Johnson, et al., 2011) (Mayhew, et al., 2011) (Meuleners & Fraser, 2015). There are clear benefits to simulators, compared to on-road assessments. Occupational therapists can use them to assess performance skills (such as visually scanning the environment) and identify patterns (like always checking over their shoulder before overtaking). They can also facilitate assessments in different driving environments (weather, traffic densities and geographic conditions); tailor situations to specific impairments and environments; and test participants under repeatable conditions (Classen, Bewenitz, & Shechtman, 2011).

In the last two decades a significant number of researchers have undertaken studies to assess driving performances using simulator driving. The capabilities of simulators have been proven efficient in multiple specific areas, with many authors being able to assess various driving measures in their studies, including:

- Approach speed, number of brake applications on approach to intersections, failure to comply with stop signs and braking response times on approaching a critical light change (Devlin, McGillivray, Charlton, Lowndes, & Etienne, 2012)
- Collision detection sensitivity – whether the approaching objects would collide or pass by them (Vaux, Ni, Rizzo, Uc, & Andersen, 2010)
- Length of the run (seconds), mean time to collision and number of off-road events (Frittelli, et al., 2009)
- Steering variability and speed variability (Uc & Rizzo, 2008)
- Crashes and measures of lateral control and longitudinal vehicle control (Rizzo, McGehee, Dawson, & Anderson, 2001)
- Approach speed for traffic signals, deceleration point for traffic signals, stopping point for traffic signals, mean speed for road curves, speed variability for road curves, mean lateral lane positions for road curves and lateral lane position variability for road curves (Stolwyk, et al., 2006)
- Manoeuvring scores, orienting scores, obeying and responding to traffic rules scores and paying attention scores (Patomella, Tham, & Kottorp, 2006)
- Speed, stop distance, lane placement, traffic signal use, hazard avoidance, and obeying traffic signs and signals (McKay, Rapport, Bryer, & Casey, 2011)
- Mean time headway, minimum time to collision, anticipation of lead vehicle braking events, number of anticipated events, standard deviation of speed, standard deviation of lane position (Andrews & Westerman, 2012)
- Reaction time, count of speed limit exceedances, speed, lateral position, number of braking events (Cantin, Lavallière, Simoneau, & Teasdale, 2009)
- Speed maintenance ability, number of driving errors, situational awareness, emergency braking ability, motor control ability (Mullen, Chattha, Weaver, & Bedard, 2008)
- Speed and pathologic discomfort (Benedetto, 2008)
- Standard deviation of curvature error, time to completion, time to collision, number of hard braking, pedestrian collision, cone collisions, average speed, excessive steering instances (Park, Cook, & Fiorentino, 2007) (Allen, Park, Cook, & Fiorentino, 2007)

Looking to validate driving simulator tasks in accord to on-road tasks, Devos (Devos, Nieuwboer, Vandenberghe, Tant, & de Weerdt, 2013) was also able to validate a series of relevant measures including: lane position at different speeds, mechanical operations, speed adaptation on different speeds, gap distances on different speeds, lane position change, anticipation and perception of traffic light and signs, visual behaviour and communication, understanding of traffic and turning manoeuvres.

Moreover, simulator performance proved to produce relevant information, even for predicting collisions for a five-year period (Hoffman & McDowd, 2010). Therefore, simulators are capable of including and allowing assessment of physical, cognitive and visual-perceptual components required for a valid driving performance assessment. A comprehensive scenario covering all three areas (physical, cognitive, and visual-perceptual) needs to be created and tested.

Part 2: Screening pilot

The pilot study aimed to broaden the team's understanding around three areas, before completing the final study design. These areas were:

- Understanding to what degree components from traditional screening tools can be transferred successfully into simulator scenarios. This process included three phases:
  - Selecting the elements to be included in the scenarios – here the team worked with specialists to determine the optimal mixture of elements to capture physical, cognitive, and visual perceptual scores. A strong emphasis was on integrating the elements into hazardous driving scenarios, while an additional observational checklist (completed by the assessor) was introduced for the elements that cannot be captured automatically, but could be observed (mobility, impulse control, self-awareness, planning, and even memory – recalling elements from the scenario).
  - Creation of the scenario – together with the XPI Simulations team, the Agilysis project team designed the best scenarios to include the elements mentioned above, accounting for the limitation of time for each driver's check.
  - Initially planned to compare the results and outputs with clinicians' assessments and to define cut-off points for referral on each of the three areas of concern (physical, cognitive, and visual-perceptual). Due to COVID19 limitations, the comparison of the results was done with the observations collected in phase one, and the cut-off points were theoretically defined from the distribution of the behavioural elements within the studied sample. Although not as good as the planned approach, the solution is strong enough to give a clear indication on the validity of the tool and the cut-off points.
- Understanding feasibility and acceptability – The original plan was to include a qualitative element comprised of questionnaires and interviews with both the practitioners and the participants. The team was only able to undertake the elements on the participants' side; the GPs and practitioners being unreachable due to COVID restrictions and limitations. The participants were interviewed to understand their attitudes to the assessment, the limitations, and any advantages they observed.
- Identify areas of success and areas of improvement which were considered in the development of the delivery programme, and draft programme design.

Ethical considerations

All participants were informed of the project's rationale; its objectives; the personal data and information collected; data protection procedures; and the health and safety measures in place during the assessment. Each participant received a short instruction on using the simulator and before proceeding, the participants gave their informed consent to participate. A short questionnaire was completed, which included questions about current medical conditions, current driving patterns, and previous motion sickness. Participation in the pilot was voluntary. The questionnaire was designed with the occupational therapist to encompass relevant elements around:

- The scope and the objective of the project
- The Covid-19 safety procedures in place
- Current medical and physical conditions of the participant, of which they are aware
- Current medication that the participant takes
- Reminder that it is the driver's own responsibility to assess their fitness to drive

More information on the retention and use of personal data is summarised in Appendix B: Risk Management and Data Storage. The appendix also details the risk mitigation strategies in place to deal with simulator sickness, issues of mobility (including the risk of falls), the detection of undiagnosed conditions, and any recommendations for participants to cease driving.

Pilot delivery

The funding for this project was awarded before the COVID-19 pandemic of 2020. The first lockdown period of March to June 2020 provided an opportunity to produce the research protocol and plan the pilot and study. The three-tier legal framework for local lockdowns was introduced in mid-October 2020, bringing forward the pilot and trial, due to the uncertainty of when local restrictions could increase.

It became evident that conducting the pilot in NHS locations would be wholly inappropriate, so the team chose to deliver the pilot in a pop-up-shop location, in Castle Quay, Banbury, ensuring all health and safety, infection control, and COVID-19 specific protection measures were in place, as described in Appendix C: COVID Safety Measures. The solution provided advantages in terms of allowing for a better control on the applied health and safety measures and protocols; the opportunity to offer participants a high level of privacy and comfort; and access to a representative sample, avoiding skewing the sample towards a specific type of pre-existing conditions.

The pilot phase took place between the 20th and the 22nd of October and had ten participants (three female and seven male) between 60 and 75 years old.

The recruitment process is detailed in Appendix H: Recruitment.

Pilot findings

The outcomes of the pilot relate to the three areas of focus described in the research protocol (feasibility, meaningfulness, and acceptability), focusing on:

- Traditional components included in the scenario
- Component measurement, assessment, and cut-off points
- Feasibility assessment
- Acceptability assessment
- Descriptive statistics of the data (components measurements), correlations and grouping.

Initial Interview

Having been booked in and given an orientation by a member of the research team, which involved watching a brief video that explained the process, seeking to allay any fears and address any potential concerns. This video is linked in Appendix K: Introductory Video.

Participants in the pilot phase were initially administered a survey (initial interview) with questions related to:

- Age and gender
- Home location (rural/urban)
- Health conditions and medication
- Vision and health conditions

- Driving habits and lifestyle

The interviews were helpful in building rapport and putting participants at ease. Interestingly, many found it difficult to gauge their health (very good, good, not so good, or poor) and reported no ongoing health problems. However, when asked to list medication it became apparent that many had ongoing conditions such as hypertension, heart problems or high cholesterol. Many required assistance to name their medications and a list of popular drugs proved helpful in identifying medication and medical conditions.

There were ten participants included in the pilot, three female participants between 72 and 76 years old and seven male participants between 60 and 86 years old. Six participants (two female and four male) live with their partners and four participants (one female and three male) live alone. All female participants live in a town, and of the males, three live in a town and four in a rural area.

Most participants are driving daily or every other day, with only 3 participants driving less often. Most of the participants drive up to 50 miles per week, and three participants are driving between 50 and 100 miles per week. No participant is driving more than 100 miles per week on a regular basis. Just over half of the participants are driving mostly unaccompanied while slightly under half of them are driving mostly accompanied.

Most of the participants described their health as very good (five) or good (four) with only one participant describing their personal health condition as not so good. All participants described their visual and hearing abilities as very good or good. Most of the participants are aware of some medical conditions they have and described a few regular medications they are taking. None of the conditions or medications discussed were likely to affect driving abilities.

The Rockwood Clinical Frailty Score (CFS) was used by the occupational therapist to determine overall health. This is a standardised metric which is widely used to identify frailty within the older population. There is a scale of nine scores, from One (very fit) to Nine (terminally ill). Individuals with frailty scores between Seven and Nine are completely dependent for personal care, from whatever cause (physical or cognitive), with those scoring Eight or Nine approaching the end of life. Most participants scored 'One' (very fit), identifying as healthy active older users. One participant was scored as 'Six' (moderately frail), indicating the person needs help with all outside activities and with keeping house. Inside, they often have problems with stairs and need help with bathing and might need minimal assistance with dressing (Knowledge Anglia NHS, 2017).

The simulator does not assess the use of a rear-view mirror. Regular actions, such as looking over the shoulder while driving a car in reverse, require high functional cervical range of movement. Compensation for loss of cervical range will result in pelvic or thoracic rotation with possible left upper limb pull on the passenger seat. To understand the range of motion each participant was capable of, a goniometer was used to assess cervical range of movement including flexion, extension, and right/left rotation. Participants were sat upright in a chair, feet on the floor with their mask removed to complete the assessment. The normal range of motion (ROM) for cervical flexion is between 0 and 50 degrees, extension is within 0 and 60 degrees, right and left rotation is within 0 to 80 degrees. Results for cervical extension and right/left rotation were all within normal range, although there was a large variance. However, within cervical flexion, five participants scored 5 degrees above normal ROM whilst three participants scored 58, 60 and 62 degrees. An explanation for these anomalies may be in the administration of the test; participants often had bulky coats and jumpers, making it difficult to isolate the cervical spine to ensure thoracic stability and prevent thoracic flexion. Moreover, the assessor was unable to determine clients' end feels of passive flexion and extension before administering the test. Considering where the cervical ROM assessment was taking place and the relationship between the therapist and participant, these limitations are understandable.

Participant scores are recorded in Appendix D: Mobility scores.

Simulator driving scenarios

In the second part of the intervention, the participants completed three driving scenarios: (1) an initial free drive scenario on the motorway to allow participants to familiarise themselves with the simulator and the commands; (2) an emergency brake scenario, to test their reaction time and their braking strength; and (3) a hazard perception scenario to test their reaction time, and their behaviour around potential hazards. Their behaviour was recorded by the simulator and the synthetic results are presented in the following subsections.

Free drive

The participants were initially introduced to a free drive scenario, on a free-from-vehicles motorway. They were instructed to take their time to get used to the environment, the simulator commands, and the simulator driving wheel manoeuvrability. A few measurements were recorded and are summarised in Table 1.

Female participants needed a bit more time to acclimatise to the simulator and the environment and drove at lower speeds within the session, when their average speed or their average maximum speed are compared to male drivers. These initial findings are consistent with the literature reviews and are encouraging in considering the simulator a good environment to replicate real driving behaviours.

Table 1 - Free drive metrics

Free Drive Gender	Number of participants	Average of FD total duration	Average of FD average speed	Average of FD max speed	Average of FD total braking time
F	3	290.67	35.66	58.84	8.97
M	7	224.19	45.94	69.79	9.00
Grand Total	**10**	**244.13**	**42.85**	**66.50**	**8.99**

Emergency braking

In the second scenario, participants were required to complete a short emergency braking scenario, on a 30mph straight road. Participants were required to drive straight and to approach the speed of 30mph, listening to the instructions they were going to receive. At a certain point, a female voice shouted “BRAKE!” then the participant had to brake until the car stopped. Associated measurements are shown in Table 2.

Female participants took longer to complete the session. This variable is negatively correlated with the average speed, as participants needed to reach a certain point in space for the signal to be triggered. As with the free-drive, female participants had a lower average speed than male participants, which correlates with the total session duration. Both male and female participants reached a maximum speed close to 30 MPH, which indicates participants were following the instruction to reach the posted speed limit of 30 MPH. On average, female participants needed 5.59 seconds from the time of receiving the command to press the brake pedal until the car stopped, while male participants needed 4.11 seconds to stop the car. The difference could indicate a combination of reaction time (faster for male participants) and strength of braking (stronger braking for male participants). On average, participants from both genders managed to stop the car within a good distance and in a good time, compared to the simulator standards.

Table 2 – Braking metrics

Emergency Braking Gender	Number of participants	Average of EB total duration	Average of EB average speed	Average of EB max speed	Average of EB total braking time
F	3	58.82	13.33	29.54	5.59
M	7	46.29	16.64	30.14	4.11
Grand Total	**10**	**50.47**	**15.53**	**29.94**	**4.60**

Again, for this scenario, the results are consistent with the literature review, suggesting that male drivers are more decisive in applying emergency brakes. The simulator proves to be a reliable environment to study driving behaviour replicating real life environments.

Hazard perception – daytime (HD)

The third scenario which participants had to complete was a more complex hazard perception scenario. Participants were required to drive in a more complex urban environment and to take appropriate measures when hazardous events developed. The indication given at the beginning was that they should use the horn in the first moment they observe the hazard, and then, or simultaneously, they should take appropriate actions to avoid risk and mitigate the hazard. The hazards included in the scenario were:

- Van emerging from driveway
- Man walking around a truck
- Car emerging from driveway
- Truck turning into junction
- Car pulling away from kerb
- Oncoming motorbike at the roundabout
- Car turning right

For all of these hazards, the following measurements were recorded:

- Horn time – the duration for which the horn was used, in relation to the first point where the hazard could had been perceived
- Brake time – in relation to the hazard position
- Average speed - in the space related to the hazard
- Duration – in the space related to the hazard
- Indicators' use time – for the hazards that require indicators

In addition, in the scenario, there were two junctions present and the following measures were recorded where they apply:

- Braking time before the junction
- Average speed when entering the junction
- Duration spent in the junction
- Indicating time before the junction

The per participant results for the hazard perception scenario can be found in Appendix M: Results.

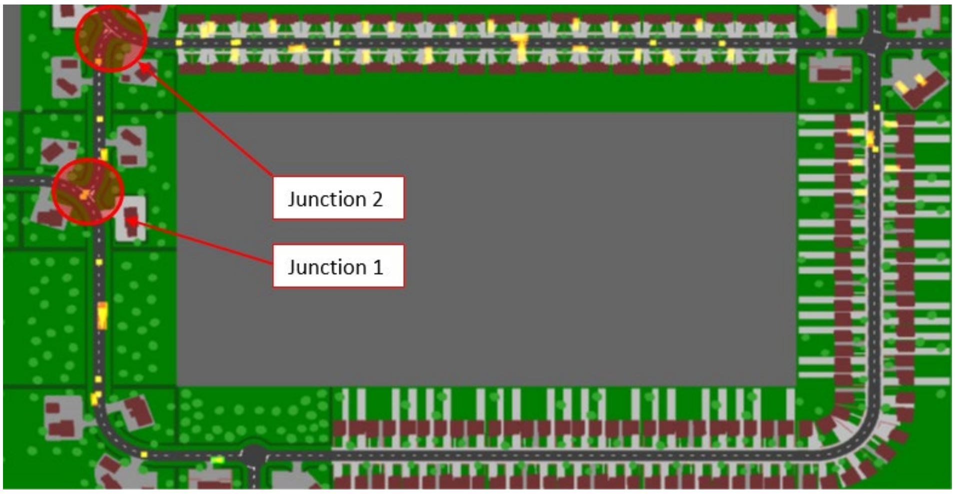
The general measures of session duration, average and maximum speed and braking time followed the same patterns for male and female participants as the free drive and emergency braking scenarios.

The time spent indicating and the time spent using the horn were also recorded for every hazard or junction and for the overall scenario. The time spent using the horn was generally very low, with three of the male participants not using it all within the scenario. Following the initial observational findings, the team spoke to the participants and discovered that some habits are harder to replicate in the simulated environment with ease, and others (such the use of the horn) are unusual requests and hard to implement after many years of driving. These are interesting findings which occurred throughout the entire intervention. As a consequence, the team decided to continue instructing the participants to use the horn, while also using other measures such as the time the brake was used, to define the moment when the hazard was detected/accounted for.

Junction 1 and Junction 2

The junctions in the scenario are different in terms of size but also right of way. Junction 1 is a T junction which has good overall visibility, and the participants are required to turn right from the main road. Junction 2 is also a T junction, with less visibility, where the participant is requested to turn right from the secondary road, being expected to drive slowly towards the main road to gain more visibility and being subject to a give way restriction. The measures were recorded only if participants came from the direction indicated in the instructions. Sometimes participants missed an instruction and therefore arrived at the junction from a different direction or road. Where these events happened values of some variables (such as braking) will appear as N/A, suggesting that not all participants had the value recorded properly.

Figure 1 - Junction layout in hazard perception scenario



For Junction 1 (with better visibility), there was a shorter length of time required within the junction, the average speed was higher and the indicating time was shorter than for Junction 2.

Hazards measures

The same measures were recorded for all seven hazards: *hazard duration*, *hazard average speed*, *hazard breaking time*, and *hazard horn use time*. Additionally, for several hazards, *hazard indicating time* was also recorded.

Hazard duration

The results, shown in tabular form in Appendix L: Results, reinforce the trends identified in previous scenarios: that female participants required more time to complete the scenarios and to pass the hazardous locations. There were some participants where no completion times were recorded, indicating that they did not manage to complete the scenario or that they took a different route to that outlined in the instructions.

Having a distribution of the measurements centred around the average is an indication that different behaviour (outliers) can be easily flagged, meaning people behaving significantly differently from the average, mean or median (for a larger sample these values and cut point can be calculated) can be flagged immediately and referred for further investigation. This observation applies to all variables where the distribution is reasonably normal and centred around a median value.

Hazard average speed

Average speed around the hazards varies significantly from one hazard to another, for both males and females, keeping the trend of male participants driving faster than female ones. The significant variations could be a result of the perceived risk of the hazard, combined with the context of the hazard. A car emerging from a driveway or a truck turning into a junction might be perceived as being more hazardous than an oncoming motorbike or a car turning right. Also, the environment in which the objects are perceived to be less hazardous are generally more friendly, with clear visibility. Nevertheless, where a normal distribution is present, outliers can be easily detected and flagged for further investigation. They can sit on either side of the distribution, as a significantly lower speed compared to the average can be caused by insecurity or fear while driving, while a significantly higher distribution compared to the average can flag unsafe behaviour.

Hazard braking time

Brakes were used very rarely around the hazards, with a slightly higher proportion of usage amongst the male participants, which can be due to their higher speeds. Nevertheless, the use of the brake alone does not seem to be a good proxy metric for hazard detection. The team proposed that in the main part of the study, the change in speed (especially deceleration) is tested for this purpose.

Hazard horn use time

Similar to brakes, the horn was not used too often, although the participants were instructed to do so when they detected a hazard. The delivery team could observe that the participants were undertaking appropriate measures (slowing down, swerving, etc) but they were not using the horn. From discussions with the participants, the team understood that the task of using the horn is an unusual one and participants had a hard time recalling the need to use it, as it is not part of usual driving tasks and is only used in exceptional situations. The participants also stated that using the horn affects the "feeling" of the environment, as in their car they would not often use the horn.

After conversations within the team, the decision was made that for the main part of the study, the instruction to use the horn will be kept, but as a voluntary task, and the focus should be on asking the participants to behave as they normally would do around a potential hazard. The change in speed (deceleration) will be used to follow behaviour around the hazard, as a proxy for hazard detection.

Hazard indicating time

Indicators were used significantly when participants felt it is appropriate and the time or duration of use does not differ significantly between male and female participants. When hazards did not require swerving or changing direction, participants used other measures (such as slowing down and waiting behind the hazard) to avoid getting into risky situations.

Pilot conclusion

Limitations related to the COVID19 pandemic necessitated several changes from the initially proposed pilot and intervention. Locations belonging to NHS and the GPs' surgeries were no longer feasible to be used in the project, and the team had to adapt the project accordingly. The pilot, as well as the main intervention, took place in a rented facility at a shopping centre (Castle Quay, Banbury). The location came with several advantages around the available space: the ability to control the environment; the implementation of COVID19 health and safety measures; and the opportunity to reach more people easily. On the other hand, a different location from the proposed one (GPs' rooms or GPs' waiting rooms) meant a different attitude for the intervention, a different way of assessing it, and in general a higher degree of scrutiny from the participants. In spite of circumstances outside the control of the investigating team the majority of the objectives of the pilot could still be explored.

In terms of meaningfulness, the aim of the pilot stage was to understand if the data captured by the simulator's software can differentiate between different levels of performance and to flag dangerous or unusual behaviour. The results proved to be promising as the data clearly differentiated between male and female participants' behaviour and could appropriately identify outliers for the investigated measures. Female participants' behaviour was safer during all sessions, driving at lower speed, taking more time to complete tasks, and using the brakes and the horn more often than male participants. There were two participants where the delivery team made observations about their nervous behaviour in the simulator, which are clearly and easily observable in the data, suggesting that significantly different behaviour can be flagged instantly, allowing for referral for further investigation. The main part of the study will bring more power into the analysis allowing more concrete conclusions to be drawn.

In terms of feasibility of the proposed solution, the simulator appeared efficient at replicating naturalistic driving, with participants manifesting a high degree of agreement with the software and the simulated environment. Tasks (such as emergency braking, instructions to follow, detecting hazards) are easy to implement and follow and provide meaningful feedback of the behaviour and the different performance levels.

Detailed discussions took place between the delivery team and the participants to understand acceptability around the tool and the screening/testing processes. Participants found the environment acceptable and appropriate, and even pointed out some of the advantages such as the reduced risk compared to on road driving, or the possibility to simulate tailored hazards, which would be harder to implement/find in on-road testing. Some suggestions around improving the realism around the steering wheel sensitivity or the movement of the environment on the screens were also addressed, but the general level of acceptance was high.

In terms of acceptability and feasibility from the health practitioners' point of view, due to the COVID19 situation and limitation, the team was not able to reach GPs to engage them in the programme, however, a trained clinician was involved throughout offering reflections on suitability. Logistically, the simulator needs a 2m by 2.5 m dedicated space, and a person to guide the assessment in the initial instances, which should also be a topic of discussion.

One aspect that was clear from the pilot phase is that participants need dedicated human assistance and guidance, as the environment is new and unfamiliar for most people (especially elderly). Therefore, the decision to increase the degree of support, to explain the intervention purpose, but also the limitations of the tool, was made for the main part of the study. Also, as results cannot be confirmed or informed by formal assessments with specialists, the main part of the study will have to drop some of the ambitious actions and focus more on understanding the data, the distribution of the data, the relationships that might exist between different variables or behaviours. In order to investigate these correlations and connections better, an extra scenario was proposed, for hazard perception, following the same lines as the first one, only this time in a night-time environment. Correlating measures between the two scenarios are to be followed, and other potential correlations with age/driving situation are to be explored.

Part 3: Main Programme

Programme design

Review pilot findings

Findings from the pilot phase of the project are encouraging. They indicate that the solution (simulator) is feasible and acceptable for the assessment task. Participants were happy with the opportunity and found the environment useful for the purpose.

The data gathered during the pilot phase from the simulator's software is also promising. The behaviour in the simulator produced many datapoints (about 30 datapoints per second), recording time, speed, position, the use of brake, the use of the horn, and use of the acceleration. Points of interest (junctions, position, and time of hazard, etc) were clearly identified in the data, and allowed, combined with the aforementioned variables, computation of variables of interest such as average speed in the session, average speed between specific point, average speed when entering a junction or approaching a hazard, braking point and braking time, use of brake or horn in specific locations, etc. All these variables allowed for comparison between participants or groups of participants. Nevertheless, the pilot phase limited the analysis options as there were only ten participants, which makes the analysis of a lower statistical power.

The main part of the study follows, to continue the investigation and further the analysis options for the existing variables, and to investigate the distribution of the variables, potential correlations, and potential cutting points (or flagging of outliers). Unfortunately, due to the restricted possibilities caused by the COVID19 pandemic, it is not possible to compare the results with on-road assessment results, as initially planned. Nevertheless, the study aims to understand the opportunities and the limitations of the tool and prepare it for the creation of a tailored scenario which can then be compared to on-road assessment to understand reliability and validity levels.

Programme development

The initial plan for the main program was to develop a more comprehensive tool capable of assessing driving performance through scoring driving abilities and comparing the results with specialists' assessments for the flagged/referred participants. The participants were supposed to be selected from the GP's patient lists and the intervention intended to take place in GPs' surgeries. This would have resulted in selection of participants with a higher likelihood to be referred for a specialist assessment, due to physical, cognitive, or visual-perceptual conditions. Although the intervention itself was not aimed at detecting specific health conditions but rather at assessing driving performance and elements of driving operation (speed, braking, hazard detection), the likelihood for drivers to present large variations in performance was thought to be high.

Due to COVID19 related restrictions, the team had to adapt the intervention, and to continue to deliver the intervention in the specially adapted environment in the same pop-up shop facility as the pilot took place. From the perspective of the initial objectives, this has several implications which will be addressed in the following paragraphs when describing the development phase. The development phase was limited in comparison to the initial objectives, but designed as to fulfil the initial critical objectives as close as possible, given the challenges that the pandemic created:

- Scenario design – the scenario was designed similarly to the pilot phase scenario, accounting for the learning and observations from the pilot, and focused on gaining more and better focused insight on the opportunities the simulator offers. Therefore, one more hazard perception scenario was added, to allow for comparison and correlation analysis between similar situations. This was done to allow understanding of the elements (measures) that are comparable or transferable from similar situations. This information helps understanding if behaviours observed in the simulator are constant in comparable situation, and therefore would allow to reduce redundancy of measurements for future programme development. Correlations can also contribute to understanding validity and reliability of the tool, the measurements, and the conclusions.

- Assessment procedure – because in the pilot phase (due to pandemic limitations) there were only ten participants, the data was not strong and reliable enough to create clear cut points and distributions, as to be able to offer immediate assessment/flagging in the main phase. Therefore, the team will use this main phase, with a significantly higher sample size to create distributions and cut points for the driving behaviour. In parallel, the delivery team will make annotations on the observation sheet for the participants where the behaviour is significantly different. These observations will be then compared with the results from the data, following to validate or invalidate the results. In the initial planning outliers who were recommended to seek a formal driving assessment would be followed to see if comparative data could be secured from their full assessment. Due to the generalised restrictions on the UK population this phase is not feasible. Comparing the observations with the results should be a strong enough validation method in the given circumstances.
- Evaluation – as with the assessment procedure, the adaptation of the delivery means that the evaluation cannot be fulfilled as initially planned. For this stage, the evaluation will have to rely on the subjective observations made by the delivery team, which will be then compared to the results of the data analysis. The comparison should be strong enough to draw conclusions on the validity and the reliability of the tool.
- Routes to delivery – initially planned to take part in GPs' surgeries, the delivery was only feasible in a pop-up shop in a shopping centre. The delivery was set to take place from 9AM to 5PM, for 7 days, between 28th of October 2020 and 5th of November 2020. Participants could apply voluntarily for the intervention, either on the spot, or using the online scheduling tool. The intervention was promoted on local media, social media, local groups and local churches focused but not limited to the Banbury and north Oxfordshire areas (see Appendix H: Recruitment).
- Routes for treatment – as referring for a specialist assessment was no longer a valid option, the route for treatment does not depend on the project team anymore. Nevertheless, participants who exhibited significantly outlying behaviours were advised to seek specialist help in order to get more insight on their driving abilities and risk.
- Delivery calendar – the delivery was originally planned to take place earlier in the year, however national restrictions (due to COVID19) narrowed the window for delivery significantly, with the main programme planned to take place between the 28th October and 5th November 2020.

Programme delivery

Delivery

The delivery of the program took place between the 28th of October and the 4th of November 2020, for six days. Planned for seven days, until the 5th of November, the delivery had to be interrupted one day earlier, due to new lockdown rules coming into place at the delivery location and elsewhere nationally. Sixty-six participants took part in the study: 21 female participants and 45 male participants. The Agilysis team deployed two team members plus the appointed Occupational Therapist to assist the participants in undertaking the assessments. All appropriate health and safety measures were put in place and respected at all times, including COVID19 related measures (see Appendix C: COVID Safety Measures).

Recruitment

As the pilot study and the main programme delivery happened in quick succession, the recruitment approach that was adopted for the pilot was continued to support the main programme. Therefore, the same methods were also employed to attract participants to the main study cohort (see Appendix H: Recruitment).

Monitoring and evaluation

Monitoring of the intervention ensured that all participants completed the appropriate elements of the program, in the correct order; that the required help and information were offered; and that the timing of delivery was constant and consistent across participants. Additional to the data collected through the initial interviews, and the data collected from the software, the delivery team filled in observations for each participant regarding their general performance, particular relevant observations and feedback about the intervention and the tool. These observations were then compared with information and conclusions from the simulator data.

Participation and follow up

Participants were offered the opportunity to give feedback on the assessment, specifically on the acceptability and feasibility of the tool, or any other information they considered relevant. Participants were also encouraged to send feedback to the team via email or to contact the team directly for feedback or additional information. They were offered the option to ask for a brief description of the result, once the project had concluded.

Participants were also offered a certificate of participation which contains contact data of the project team and results of their assessment in the intervention, on a general level and by hazard.

Evaluation

Methodology

This project applied mixed methods of research and evaluation, on different levels:

- Mixed methods approach – a mix of qualitative and quantitative methodologies were deployed to assess the objectives of the project. With a significant proportion of the objectives addressing qualitative elements, this level was focused on the initial interviews/surveys and on the observational elements.
- Methodology validation – at this level, quantitative methods were deployed to analyse, compare and correlate measures according to the specific levels of validity and reliability. Initial cut-off points were defined, the tool's results compared with other available information, redundant elements identified, as well as areas to be improved. Comparison to on-road assessment could not be pursued under the prevailing circumstances.

Data collection and management

All data was anonymised from the collection phase. Participants received a project code (devised from the order and the day of participation in the intervention) for future comparison with other data. Data collection was done both manually and automatically:

- For the qualitative sections (initial interviews/surveys) data was mainly collected manually, analysed and reviewed by the team, recorded in a coded spreadsheet, and then archived.
- The quantitative data was mainly collected automatically, out of the simulator's software, and then used for analysis and modelling.

Findings

Data produced from the main programme is shown in detail in Appendix M: Results and summarised in the following section.

Initial Interview

In the initial session, participants responded to a survey (initial interview) with questions related to:

- Age and gender
- Home location (rural/urban)
- Health conditions and medication
- Vision and health conditions
- Driving habits and lifestyle

Table summarising these data are shown on page 70.

Participation was voluntary and self-selecting; individuals chose to participate after receiving promotional materials or passing the pop-up shop. No quotas on gender or age were applied, seeking instead to achieve a good sample size within the time period. There were 66 participants in the intervention, 21 female (between 65 and 78 years old) and 45 male participants between 56 and 91 years old. More than two thirds of the participants live with their spouses or partners, and about a quarter live alone. The remaining are living either with their children or in a different context. Two thirds of the participants live in an urban area.

Half of the participants described their health as good and another (about 40%) described it as very good. Less than 10% of the participants described their personal health condition as not so good (four participants) or poor (one participant). The majority of the participants described their visual abilities as very good or good and their hearing abilities as very good or good, with six describing it as not so good.

Almost half of the participants drive daily and nearly half drive every other day or twice a week, leaving three who only drive weekly and four who only drive monthly. For male participants, there is a higher proportion driving daily, compared to female participants. Female participants are driving shorter weekly distances, with the highest proportion driving between 20 and 50 miles per week, followed by those driving less than 20 miles per week. For male participants, the highest proportion of them are driving between 50 and 100 miles per week, followed by the proportion of those driving between 100 and 250 miles per week. Few participants only drive on their own, with the others mostly driving accompanied or a mixture of accompanied and unaccompanied.

Similar to the pilot phase, most of the participants are aware of some medical conditions they have and described a few regular medications they are taking. None of the participants was aware or recalled being informed that any of their conditions or medications were likely to affect their driving abilities. Clinical Frailty Scores and some particular mobility elements were measured and recorded; the participants exhibited, in general, good levels of mobility, with the majority of them having a high mobility level for their age. More details can be observed in Appendix D: Mobility scores.

Non-simulator insight (observations and discussions)

Additional to the data collected through the survey and from the simulator software, the team observed and recorded data regarding driving behaviour in the simulator and also recorded participants' opinions and suggestions about the feasibility and acceptability of the tool.

A small number of the target population did not know what a simulator was; none of the participants had used a driving simulator before and many wished to see it prior to taking part. Some participants perceived the simulator as 'unfair' because it is so different to driving a car and felt it should not be used as a tool to determine safety or ability.

Following the three-day initial pilot, the occupational therapist began to record any qualitative feedback post-simulation. Inevitably, participants who had negative experiences were more vocal, with several reporting the experience as unrealistic. Of the 67 participants in the intervention phase, 21 commented negatively about the lightness and torque of the steering wheel, which created oversteer, less vehicle control and increased stress. Many participants reported difficulty adjusting to this aspect of the simulator.

Others commented it was an unreal, (not necessarily unfair) experience and thought more time to adjust within the free driving sessions may be beneficial. Two female participants reported it took time to get used to the simulator, but their confidence then increased making it accessible. Future trials may need to consider longer free driving sessions.

Nine reported it was not like driving a car and an additional four commented that they felt the simulator was not good enough as an older driver assessment tool. Seven participants stated it produced low driver confidence. However, most recognised the perceived benefits of a mobile simulator as part of a series of older driver assessments, providing it is a realistic driving experience. As the programme progressed, participants were alerted to the fact the experience will vary from the performance of their car, in an attempt to manage driver expectation and acceptability.

There were comments about specific elements of the simulator:

- Four contributors remarked the brakes were delayed and slow to respond,
- One attendee reported the road signs were too small whilst several commented it was "hard to know if other cars were moving and at what speed". Many found the night drive too dark.

There were also some comments and suggestions related to:

- The sensitivity of the steering wheel and of the pedals - some participants felt that the steering wheel and the pedals did not feel 100% realistic, but all participants agreed that the environment is immersive and some of them reported feeling real movement in the seat.
- The absence of mirrors – most of the participants noted the absence of lateral mirrors but they did not feel the need to use them very often, due to the way the tasks were created.
- The movement of the image on the screen – some participants reported that the image on the screens sometimes felt unrealistic.
- The realism of the scenario – as the scenarios were created for specific tasks, they were not always replicating real-life levels of traffic, or pedestrian movement. Some participants found that a positive aspect, allowing them to focus on the tasks, but were worried that this is a simplification that might affect the validity of the assessment

As set out in the Research Protocol, simulators can trigger motion sickness, particularly amongst women and older people. Eight participants (four male and four female) reported nausea during their simulator experience, with an additional four feeling queasy initially. Six participants terminated their session in the simulator (four females and two males). All reported motion sickness and/or anxiety as their reason for stopping, however none of the participants vomited in the trial.

A few reported the driving tasks were unclear, recommending visual hazards for the emergency stop rather than an audible command. Some required clarity surrounding the hazard perception task, not considering anything that caused them to change speed or direction as a hazard. Many were reluctant to honk their horn to indicate risk (as reflected in the analysis). As the trial progressed, additional instructions were given to advise participants what constitutes a hazard.

There were three participants who struggled with the simulator physically; two were tall men and a third was a lady who felt the seat was too low.

Regarding the feasibility and acceptability of the tool, the majority of the participants displayed a positive attitude towards it, and identified a series of advantages such as:

- Objective tool and consistency of assessment
- More opportunities to schedule assessments
- The opportunity to deliver assessments in public locations like shopping centres or hospital waiting rooms (once the tool is tested and validated)
- No risk, compared to the risk of being exposed to traffic in an on-road assessment
- The possibility to simulate hazards that are harder to find on the road
- The possibility to tailor interventions for different groups of users

The team made observational notes on the driving behaviours, to be able to compare with the driving simulator data analysis findings to see if the behaviours are observable in the objective data. Behaviours included missed turns, incomplete tasks, misinterpretation of tasks, low speed, overconfidence, and low confidence.

Simulator driving scenarios

In the second part of the intervention, the participants completed four driving scenarios: (1) an initial free drive scenario on the motorway to allow participants to familiarise themselves with the simulator and the commands; (2) an emergency brake scenario, to test their reaction time and their braking strength; (3) a hazard perception scenario to test their reaction time, and their behaviour around potential hazards; and (4) another hazard perception, with the same route and the same hazard as the previous one, only in a night-time environment, to test participants' behaviour around potential hazards in a night-time environment. The addition of the fourth scenario allowed for comparison and correlation analysis to be undertaken to better understand the effects of learning (repetition of hazards) and the consistency of behaviour under the simulated environment.

Free drive

The participants were initially introduced to a free drive scenario, on a free-from-vehicles motorway. They were instructed to take their time to get used to the environment, the simulator commands, and the simulator driving wheel manoeuvrability.

As with the pilot phase, female participants took slightly longer to complete this session and get used to the simulator than male participants. Female participants also had lower average, maximum and 85th percentile speeds. Female participants spent much longer than male participants using their indicators and also spent more time braking in the scenario. Summary data are provided on page 76.

Analysis was undertaken to identify any correlations between average speed in the scenario with drivers' age, weekly driving distance and driving frequency of participants. There is a negative, weak and not significant (*P=.11*) correlation between average speed in the free drive scenario and the age of the driver (average speed decreasing as the age of participant increases). There was a positive, weak but significant (*P=.029*) correlation between average speed in the free drive scenario and weekly driving distance (with average speed increasing as weekly driving distance increases). There was a positive, weak and not significant (*P=.20*) correlation between average speed in the free drive scenario and driving frequency (with average speed increasing as driving frequency increases).

The free drive scenario is the least complex of the four completed, with participants having the freedom to choose their own pace, without any instructions. The following scenarios are increasingly more complex.

Emergency braking

In the second scenario, participants were required to complete a short emergency braking scenario, on a 30mph straight road. They were asked to drive straight and to approach the speed of 30mph, paying attention to the instructions they were going to get. At a certain point, a female voice shouted "BRAKE!", when the participants had to brake until the car stopped.

The gender differences were less apparent in this scenario, with session duration, average speed, maximum speed, 85th percentile speed and total braking time similar for male and female participants. The results also indicate that participants followed the instructions, in terms of reaching the target speed of 30mph and stopping the car within a good distance and in a good time, compared to the simulator standards. The summaries are shown in Table 30.

For this scenario, given the similarities between male and female participants, further analysis was undertaken on average speed and average braking time, by gender (shown in the Emergency Braking section from page 78. Intervals were calculated to identify outlier participants, whose average speed was outside the normal distribution. The identification of these outliers provides a flag from the simulator for participants who should be investigated more closely.

Analysis was undertaken to identify any correlations between average speed in the emergency braking scenario with drivers' age, weekly driving distance and driving frequency of participants. There is a negative, weak and not significant (*P=.27*) correlation between average speed in the emergency braking scenario and the age of the driver (average speed decreasing as the age of participant increases). There was a positive, weak but significant (*P=.053*) correlation between average speed in the emergency braking scenario and weekly driving distance (with average speed increasing as weekly driving distance increases). There was a positive, weak and not significant (*P=.30*) correlation between average speed in the emergency braking scenario and driving frequency (with average speed increasing as driving frequency increases).

Similar to the free drive scenario, the emergency brake task is not very complex. The following two scenarios are increasingly more complex.

Hazard perception – daytime and night-time

The third and the fourth scenarios participants had to complete were more complex hazard perception situations. Participants were required to drive in a more complex urban environment (in one scenario in daytime, and in the next scenario during the night-time) and to take appropriate measures when hazardous events developed. The indication given at the beginning was that they will use the horn in the first moment they observe the hazard, and then, or simultaneously, they should take appropriate actions to avoid risk and mitigate the hazard. The hazards included in the scenarios were:

- Van emerging from driveway
- Man walking around a truck
- Car emerging from driveway
- Truck turning into junction

- Car pulling away from kerb
- Oncoming motorbike at the roundabout
- Car turning right

For all of these hazards, the following measurements were recorded:

- Horn time – the duration for which the horn was used, in relation to the first point where the hazard could had been perceived
- Brake time – in relation to the hazard position
- Average speed - in the space related to the hazard
- Duration – in the space related to the hazard
- Indicators' use time – for the hazards that require indicators

In addition, in the scenarios, there are two junctions present and the following measures were recorded where they apply: braking time before the junction; average speed when entering the junction; duration spent in the junction; and indicating time before the junction.

Table 35 summarises the session duration and braking time, by gender. For both the daytime and night-time hazard perception scenarios, female participants took longer than male participants to complete the scenario. Female participants spent slightly longer braking in both scenarios, than male participants. Male participants recorded slightly higher average speeds in both hazard perception scenarios than female participants, whilst maximum speeds were similar for both genders (shown in Table 36).

Analysis was undertaken to identify any correlations between the daytime and night-time hazard perception scenarios, using session duration, braking time and average speed. Analysis was also undertaken on the daytime scenario, using average speed against drivers' age, weekly driving distance and driving frequency of participants.

There was a positive, moderate and significant correlation (*P=.000*) between the average duration of the daytime scenario and the average duration of the night-time scenario (meaning the average duration of both scenarios increased together). Similarly, there was positive, weak and significant correlation (*P=.000*) between average braking time in the daytime scenario and the average braking time in the night-time scenario (with braking times increasing together in both scenarios). Likewise, if average speed was high in the daytime scenario for a participant it was similarly high in the night-time scenario, shown through a positive, moderate correlation (*P=.000)*.

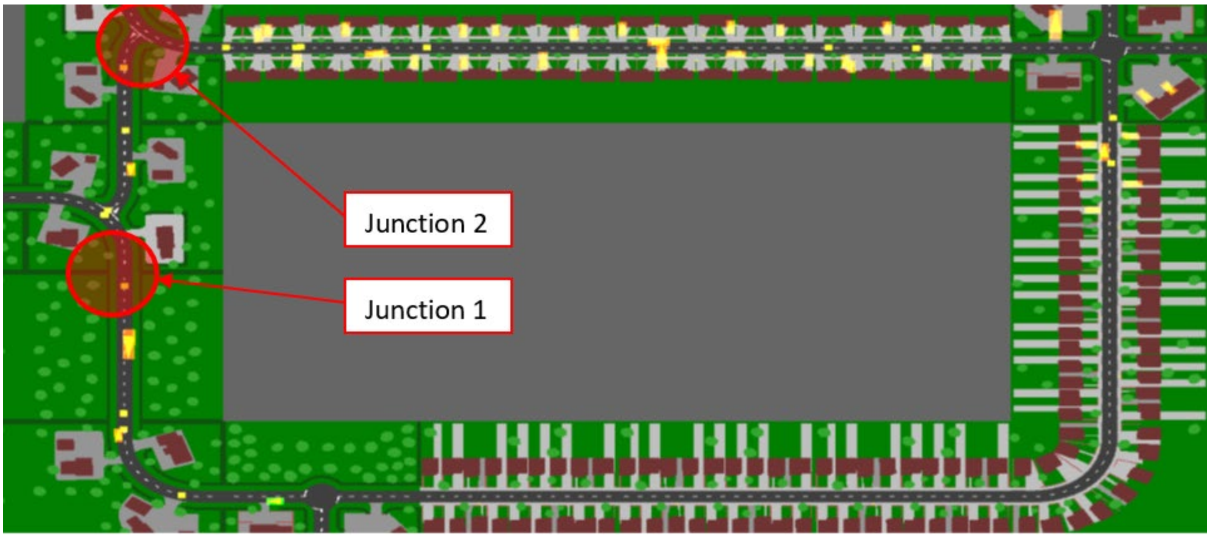
Although technically there was a negative correlation between average speed and age in the daytime scenario (so average speed decreased as age increased) the result was not significant (*P=.15*). There was a positive, weak but significant correlation (*P=.004*) between average speed in the daytime scenario and weekly driving distance (meaning average speeds increased as weekly driving distances increased). There was also a positive, weak and not significant correlation (*P=.07*) between average speed in the daytime scenario and driving frequency (again, indicating that average speeds increased with driving frequency increases).

Outlier participants, identified in the data for both the daytime and night-time hazard perception scenarios, are shown in Table 37 and Table 38. The same participants tended to be flagged in both scenarios, which is encouraging. It is also positive to observe the consistency in correlations between behaviours in the various scenarios. The identification of outliers can be improved through the elimination of unusual values, which are an indicator of either errors in data collection or errors in the delivery process. It is also possible to set a wider interval for flagging outliers, to ensure all 'suspect' behaviours are identified.

Junction 1 and Junction 2

The junctions in the scenario are different in terms of size but also right of way. Junction 1 is a T junction which has good overall visibility, and the participants are required to turn right from the main road. Junction 2 is also a T junction, with less visibility, where the participant is requested to turn right from the secondary road, being expected to drive slowly towards the main road to gain more visibility and being subject to a give way restriction. The measures were recorded only if participants came from the direction indicated in the instructions. Sometimes participants missed an instruction and therefore arrived at the junction from a different direction or road. Where these events happened values of some variables (such as braking) will appear as N/A, suggesting that not all participants had the value recorded properly.

Figure 2 - Junction layout in hazard perception scenario



Junction analysis was undertaken for the daytime and night-time scenarios. There was almost no difference in the average duration of time participants spent in the two junctions in the daytime and night-time scenarios. However, average speed was lower and indicating time higher for both junctions at night-time, compared to the daytime scenario.

Hazards measures

In general, having a distribution of the measurements centred around the average allows for easier identification and flagging of different behaviour (outliers), meaning people whose behaviour is significantly different from the mean can be flagged immediately and considered for further investigation. This observation applies to all variables with a normal distribution, centred around a median value. The following subsections and tables are focused on identifying the distribution characteristics (mean, standard deviation, range, etc) and identifying the 5% most distant outliers.

Hazard duration

Hazard duration (for both the daytime and night-time scenario) varies slightly across participants of the same gender, with several exceptions where the variations can be higher, with data shown in Table 40 and Table 42. The same trend as in the previous scenarios can also be observed in the daytime hazard perception scenario: female participants needing more time to complete the scenarios, and to pass the hazard locations. For the night-time scenario, there are some hazards for which female participants needed longer and others where male participants took longer to complete the task.

A number of participants did not complete the task properly or did not complete it at all, recording 0.00 seconds duration for some or all the hazards. The remaining identified outliers were recorded with values outside the 95% interval (shown in Table 41 and Table 43).

Hazard average speed

Average speed around the hazards varies significantly from one hazard to another, for both males and females, maintaining the trend of male participants driving faster than female ones. The significant variations could be a result of the perceived risk of the hazard, combined with the context of the hazard. A car emerging from a driveway or a truck turning into a junction might be perceived more hazardous than an oncoming motorbike or a car turning right. Also, the environment in which the objects are perceived to be less hazardous are generally more friendly, with clear visibility. Nevertheless, where a normal distribution is present, outliers can be easily detected and flagged for further investigation. They can sit on either side of the distribution, as a significantly lower speed compared to the average might indicate insecurity or nervousness while driving, while a significantly higher distribution compared to the average can flag unsafe speed choice.

For this section, the participants recording zero average speed were excluded from the analysis at all stages focusing on understanding outliers according to the distribution of those recording positive speeds in the area corresponding to the hazards. Average speeds and outlier data are shown in Table 44 to Table 47.

Hazard braking time

Brakes were used very rarely around the hazards, with a slightly higher proportion of usage amongst the male participants, which might be due to their higher speeds. Nevertheless, the use of the brake alone does not seem to be a good proxy metric for hazard detection. Deceleration was also followed around the hazard, but the data is very inconsistent and the percentages of participants decelerating in the areas corresponding to the hazards in a different manner from the general course is very low. As a consequence, the analysis is not considered to be informative enough for the purpose of the study.

Hazard horn use time

Similar to brakes, the horn was not used too often, although the participants were instructed to use appropriate measures (slowing down, swerving, etc) while not using the horn, these data was again inconsistent in the study. From discussions with the participants, the team understood that the task of using the horn is an unusual one and participants had a hard time recalling the need to use it, as it is not part of usual driving tasks and is only used in exceptional situations. The participants also stated that using the horn affects the “feeling” of the environment, as in their car they would not often use the horn. For subsequent research, the team proposes a different approach to hazard detection record, which would combine the recording of speed (and brakes/deceleration) with the actioning of the driving wheel and the position on the road. For the existing study, these aspects were impossible to calculate because of the way the data is recorded; the car position being a relative measure to the road centre, which is a mobile value in itself. Therefore, some more development effort has to go into the software to allow for these measurements to be calculated when they detected a hazard.

Hazard indicating time

Indicators were used more often when participants felt it was appropriate and the time or duration of use does not differ significantly between male and female participants, or between daytime and night-time. When hazards did not require swerving or changing direction, participants used other measures (such as slowing down and waiting behind the hazard) to avoid getting into risky situations. Results are inconsistent, though, and as it was not mandatory or an instruction to indicate, it would be unfair to consider the adoption of behaviour as an indication of safe behaviour.

Outliers identified

The outliers identified in each of the analyses were grouped and analysed together. Outliers are respondents identified three or more times and presented in Table 48. Although being an outlier means that the analysed behaviour (for each case of analysis) exhibited a recorded value amongst the 5% furthest away from the sample mean, if a participant was recorded in only one or two cases, they were excluded from the table as it is possible that those cases were isolated behaviours. Where there were three or more cases of the same participant being identified as outliers, it can be considered that the analysis is identifying consistently outlying behaviour, especially if those behaviours happened in different scenarios.

Participant P14D8, for example, spent significantly higher time on the scenarios, compared to the average duration; they drove at significantly lower speeds; and spent significantly more time braking on the scenarios. This is consistent with the observational sheet which had notes on participant P14D8 as: *driving slow, insecure, approaching hazards and junctions with hesitation.* Other relevant observations from the observation sheets regarding participants are:

- P11D4 – low speed, multiple unnecessary stops, high variability in speed - *identified as outlier*
- P11D8 – low speed, lack of confidence – *identified as outlier*
- P9D8 – low speed night-time, possible visual impairment – *identified as outlier*
- P5D9 – misinterpreted the instructions, low speed, insecure – *identified as outlier*
- P1D4, P2D4, P10D4 – misinterpreted the instructions, did not finish the scenarios – *identified in the analysis with missing data*
- P8D5 – overconfident, high speed, missing hazards – *identified as outlier*

Of the 11 outliers identified in the table, only two had no medical conditions. One of these has Chronic obstructive pulmonary disease (COPD), which has been identified in other simulator studies as a condition impairing driving performance (Skovus Prior, Troelsen, & Hillberg, 2015) (Orth, et al., 2008) (Karakontaki, et al., 2013) (A further two COPD patients were identified as outliers in at least one of the analyses). COPD is a multicomponent disease which can impact neuropsychological function. Two of the outliers suffer with rheumatoid arthritis, which has been found to reduce steering variability and increases erratic/harsh braking and accelerating (Michaud, et al.) (Cranney, et al., 2005) One participant suffered with a number of conditions, including sleep apnea and diabetes, both of which can impact on driving performance (George, Boudreau, & Smiley, 1996) (Shu, et al., 2020). Other participants' conditions which could impact on their driving performance were cataracts, stroke, vertigo and asthma. The presence of these conditions amongst the outlier participants indicates that the simulator is able to detect differences in driving performance related to health. In practice, these outliers would be referred for further investigation.

Strengths and opportunities

The main strengths of the study come from the innovative way it assesses driving behaviour in a safe environment, using a simulation-based scenario that is readily accessible to a wider population of older drivers. The study showed that the method is not only feasible but also meaningful, exhibiting results in line with the observations taken by the team members during the simulator assessments. The tool could allow for a better selection of drivers to be referred to further investigation, increasing the efficiency of referrals to assessment and giving the opportunity of a quick screening that would overcome practitioners and GPs' own specialism biases or reticence to refer.

Another strong benefit of the method is that it assesses driving performance rather than looking for specific conditions, whilst not excluding behaviour affected by particular conditions. Therefore, the drivers are screened for their driving behaviour and not for medical conditions, which will allow identification of behaviours also affected by lack of practice, by forgetting driving rules or any other similar reasons. While it will not identify specific conditions, the drivers can be referred for further investigations of possible causes for the outlying behaviour.

In terms of opportunities, the technology around simulators and their capabilities is seeing a rapid development, allowing not only for more comprehensive and realistic simulations, but also for more affordable solutions for deployment, where necessary (GP practices, public spaces, etc.). The development of an affordable solution will allow for an initial screening which will reduce the number of unnecessary assessments, and therefore increase the efficiency of the practitioners.

Limitations, threats and weaknesses

The main limitations and weaknesses of the study come from the COVID19 specific restrictions, and from some limitations due to budget restrictions.

Due to the pandemic restrictions, the project had to adapt some aspects, as follows:

- Change the location from GP practice locations to a shop environment. Although the change brought a series of advantages in terms of control of the environment, access to potential participants and the ability to control for health and safety measures, it also came with some weaknesses:
    - Selection of participants – participants took part in the intervention on a voluntary basis, which is expected to have created a selection bias towards more self-aware participants with higher performance levels. Operating in conjunction with GPs, the intervention would be expected to target participants more likely to exhibit lower performance in the scenarios. Nevertheless, the results showed a meaningful distribution of performance which allowed for defining the outlying behaviours.
    - Accessibility and feasibility – the approach was largely seen as feasible, acceptable and accessible by the participants, given the circumstances, with some clear views on how the driving experience could be improved and made more realistic. It should also be investigated if these feelings are influenced by delivery in other locations, or in cases where the assessment is regarded as advisory, or even mandatory, as opposed to voluntary.
- Health practitioners were not contactable at the time, given their priorities of dealing with the pandemic. This manifested as an inability to work with GPs and healthcare practitioners on delivery as well as undertaking the accessibility, acceptance, and feasibility interviews and focus groups. Understanding their willingness to embrace a simulator-based approach as a triaging tool will be critical in any future development of the approach.
- Inability to compare results to on-road assessments – some comparative analysis between the screening undertaken with the simulator and on road performance would enrich understanding and applicability of this approach.

Restrictions on the budget affected the intervention as follows:

- Use of existing scenario – the budget for the simulator was only enough for the lease of an existing machine and the limited adaptation of existing scenarios for the purpose of the project. The existing scenarios, although comprehensive, were created for training professional drivers, and are therefore more complex than might be required for the project. Nevertheless, the selected environments presented a moderate difficulty and the participants managed to fulfil the tasks to a high level.
- Measures – the existing scenarios and software only allowed for a series of predefined measures. Exploration of other relevant metrics may add to the fidelity of the tool if separately explored.
- Sample size – given that there were increased costs associated with the hire of the shop facility (and COVID restrictions) the sample size was of 76 participants in total, which meant that it was difficult to analyse the data according to certain variables (age, gender, etc) and still get a significant quantity of data. A larger sample would allow weighting the cut-off points and the decisions to include some characteristics such as age, gender and even experience, in order to understand the behaviour in a narrower context.

Other limitations and weaknesses exist around data collection and analysis:

- Recorded values did not always follow a normal distribution – having more data would allow for the creation of a normalised distribution and would decrease the effect of any anomalous results on the analysis.
- Variation in time for explaining the intervention – some participants had many questions and required more time to be introduced to the project, which affected their time but also, sometimes, according to their understanding of the project, their attitudes changed towards being critical and looking for elements that can be improved. While this is good feedback, it may have affected the ability of participants to focus on their task in the simulator and changed their focus towards investigating the simulator capabilities.
- Possible bias in the sample - for this project, the participants participated voluntarily, therefore there might be an auto-selection bias in the acceptance level.
- Delivery consistency – due to factors that were difficult to control for, the consistency of delivery was sometimes affected. For example, a participant might arrive late and therefore the time allocated for their session had to be adapted accordingly, which might have reflected on their performance. In a limited number of cases, participants came with partners or friends who also wanted to undertake the assessment. Finding time to allow the extra participants to be assessed might have reduced some delivery times.
- Outliers – looking for outliers in the 5% furthest away from the mean sometimes is not enough to capture unusually low or unusually high values. With a higher number of participants, the researchers might want to adapt the interval to a more appropriate one (10%, 15%) for the distribution. Also, adapting for the skew of the distribution might be considered in the future when defining cut-off points.

Conclusion

The project had been successful in identifying different levels of driving behaviour in older drivers. Identifying most of the participants with relevant observations on the observational sheet in the data analysis, either as outliers (5%) or with missing data, is a very encouraging result as it confirms that the tool has the potential to flag significantly different behaviour.

Moderate and significant correlation between the behaviour on similar tasks in different scenarios shows that the drivers' behaviour in the simulator remains constant when confronted with similar cognitive or physical load, which on one hand increases the reliability of the tool, and on another hand allows for the creation of shorter scenarios, avoiding redundancy of tasks (with the purpose of testing reliability). Therefore, the simulator tests were proven to be a meaningful assessment of driving abilities, for the analysed sample.

The tests are feasible to deliver with the help of one guiding person, in the real world. Future developments of the scenarios and the test procedures can allow for clear instructions to be included in the simulator introduction and therefore the assessment could be delivered with relatively little assistance.

The participants largely accepted the simulator as an assessment tool and easily became familiar with the environment, mostly requiring around three or four minutes of free drive and a few clear indications on the similarities and differences from a real car environment. Some of the participants even found the testing more acceptable than a traditional assessment, as they consider it is safer than an on-road assessment; should be easier to reach and book (at GPs' locations or in other specific locations); and gives the opportunity to simulate potential hazards and situations that might not appear in an on-road assessment. Several participants underlined that the difficulty of the simulated environment might be higher than on the roads they regularly drive on, but most saw that as a good thing, as driving is not always happening as planned.

Recommendations

Accounting for the encouraging findings but also for the limitations of the current project, the main recommendations for future stages are:

- Conduct a wider experiment to:
    - Deliver the intervention in more, nationwide locations, to allow for understanding and weighting for local driving culture, and to collect significantly more data.
    - Deliver the intervention in a primary healthcare setting for comparison with a group being directly referred for assessment by clinicians.
- Stakeholder collaboration
    - For key stakeholders (Department for Transport, mobility centres and primary healthcare providers) to collaborate to ensure that the experiment is conducted in a range of locations across the country, collecting data on the feasibility and acceptability of the delivery of the simulator in a clinical setting, and the referral processes and communication required to positively handle the results.
    - For those stakeholders to collaborate in identifying the best setting(s) for simulator testing and to document the processes required for wide scale implementation; assuming results indicate continued support for simulator testing as a reliable, acceptable and feasible method of screening.
- Simulator specifications
    - Work with simulator providers to develop increased realism in their simulators with particular attention to steering force and feedback, availability of lateral mirrors and ability to switch between manual and automatic gears.
    - Include measurements for swerving.
    - Develop automatically generated report for drivers indicating performance based on scores, with appropriate referral criteria.
- Scenario specifications:
    - Develop a specific scenario, tailored to the target audience, which is clear and appropriate for the task.
    - Explore the option of participants selecting a scenario appropriate to their driving requirements.

    - Include clear instructions at the beginning of the scenario, and in each phase.
    - Allow sufficient time (three to five minutes) for accommodation with the simulator or a dedicated orientation session that enables familiarisation.
    - Include a range of common hazards, experienced by most drivers.
    - Include measures to assess the behaviour around the hazard, rather than relying on participants use of the horn (assessing by comparison to the behaviour when no hazard is present; create indices instead of raw value for cut-off points around hazards).
    - Consider the impact of emerging vehicle technologies, including these within simulated scenarios as they become more ubiquitous in the vehicle fleet.
- Validation and cross-validation
    - Compare the insight and the results to on-road assessments results.
    - Compare and investigate correlation of the results with medical assessments.
- Intervention delivery
    - Allow sufficient time for the sessions and between participants – including time for the participant to have breaks between scenarios, discussion of observations and scoring and, resetting/cleaning the simulator as required.
    - Develop an observation protocol, that reduces demand on the instructor providing guidance on use of the facilitator as well as capturing information from observations.

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Appendix A: 62 Viable Interventions

Interventions	Intervention Function	Suitable	Acceptable	Feasible	Extendable	Sustainable	Total Score
Mandatory eyesight checks	Regulation	32	30	26	35	35	**157**
Providing on and off-road driver assessments and refresher training	Service Provision	34	30	24	32	31	**157**
Mandatory health checks	Regulation	34	30	22	32	33	**151**
Mandatory driver retraining at 70	Regulation	32	30	22	33	32	**149**
Driving Safer for Longer (assessment drives)	Service Provision	33	30	22	32	31	**148**
Gloucestershire's SAGE	Service Provision	33	29	22	32	31	**147**
Providing training on coping strategies, such as how to plan trips and when not to drive	Service Provision	32	30	20	30	30	**142**
Providing mobile simulator-based screening, which can be delivered in conjunction with healthcare practitioners, to use a simulator to understand driver needs (both cognitive and physical) and enable them to be supported in safer driving	Service Provision	31	31	20	32	28	**142**
Use of relicensing at 70 as trigger for incentivised services, such as eye tests/glasses, health checks, and driving assessments	Service Provision	32	27	24	29	29	**141**
By financially supporting health care professionals (such as GPs) to assess older patients in relation to their driving and to support them with advice on eyesight, medication and physical frailty, and how these factors could potentially impact on their	Environmental/ Social Planning	31	29	18	29	31	**138**

Interventions	Intervention Function	Suitable	Acceptable	Feasible	Extendable	Sustainable	Total Score
driving. It could work as part of a referral system to assessment centres.							
A review of specific high-KSI routes to establish locations for re-engineering, especially where the location could be challenging for an older driver	Environmental/ Social Planning	31	29	21	29	26	**136**
A review of signing and lining on routes to reduce confusion and ensure that key information is noticed and processed	Environmental/ Social Planning	28	28	24	28	27	**135**
Provide supported 'retirement from driving' process that allows road users to manage their migration away from dependence on owning/driving	Service Provision	31	28	21	29	26	**135**
Offer a free driving assessment to members of local groups	Service Provision	29	30	18	29	29	**135**
Creation of a syllabus for older driver training	Guidelines	29	27	22	27	29	**134**
DVLA obligation to provide drivers with updates to legislation	Guidelines	28	28	20	31	27	**134**
Telematics with incentives	Service Provision	30	28	19	31	26	**134**
Providing rural-specific additional driving lessons, to increase experience on these road types	Service Provision	30	29	19	28	28	**134**
Advertising alternative transport options	Communications/ Marketing	30	27	21	30	25	**133**
Free senior railcard	Service Provision	31	32	14	29	27	**133**
Improved seating at bus stops / transport hubs to make transfer between modes easier	Environmental/ Social Planning	27	27	22	29	27	**132**
Retesting at 70 for relicensing	Regulation	35	21	16	28	30	**130**
Engineering guidance on infrastructure that works for older driver	Guidelines	29	30	17	25	28	**129**

Interventions	Intervention Function	Suitable	Acceptable	Feasible	Extendable	Sustainable	Total Score
Telematics with feedback	Service Provision	27	21	22	26	28	**124**
Subsidised local taxi services	Service Provision	31	32	12	23	26	**124**
Facilitating peer-to-peer conversations on driving skills	Guidelines	25	24	20	27	25	**121**
Hampshire Older Drivers Forum (internet information)	Communications/ Marketing	23	23	19	32	24	**121**
Insurance policy with conditions (GDL style limitations)	Service Provision	29	21	16	29	26	**121**
Vouchers for days out with travel included	Service Provision	25	31	14	27	24	**121**
Providing alternative forms of transport to those living in rural areas, to limit the risky situations in which they find themselves in. This could be a community-based transport scheme that could be used to take older people to and from core locations or to places during poor weather, so they have the option not to drive	Service Provision	27	30	14	23	25	**119**
A scheme like Carfit, which was developed by the American Automobile Association, and also used in Australia, which draws on occupational therapists and driving instructors to offer tailored advice on how the car and driver can 'fit' together to maximise safety and comfort.	Service Provision	26	26	20	24	22	**118**
Complimentary home delivery service for groceries	Service Provision	28	30	12	22	25	**117**
A social marketing campaign to persuade older drivers to undergo self-assessment	Service Provision	27	22	21	27	19	**116**
Mandate that highway authorities consult & inform older people's groups about infrastructure changes	Regulation	24	27	16	25	24	**116**
Personal mobility & travel clinics	Service Provision	28	24	18	22	22	**114**

Interventions	Intervention Function	Suitable	Acceptable	Feasible	Extendable	Sustainable	Total Score
Insurance policy with bundled incentives (e.g. rail tickets, free coach journeys, reduced-price Saga holidays included)	Service Provision	27	22	14	26	25	**114**
A social marketing campaign to emphasise that old doesn't mean bad! The campaign would try to dispel myths about age and driver skill to increase empathy towards older drivers amongst other drivers	Communications/ Marketing	24	24	15	30	20	**113**
Classroom based education programme	Service Provision	29	22	14	25	22	**112**
A social marketing campaign to increase knowledge about the benefits of self-regulation, which include reducing stress and pressure for older drivers and highlighting that they have the power to decide when and where they drive, through good trip planning	Communications/ Marketing	26	23	20	26	16	**111**
Encourage older person's charities to 'lead the conversation' on healthy ageing and mobility; might include a 'network of champions'	Communications/ Marketing	22	23	19	23	22	**109**
Vehicle purchase guidelines for older drivers, focussing on best safety features for older occupants	Environmental/ Social Planning	22	22	18	24	22	**108**
Complimentary transport services for bingo, bridge & church	Service Provision	21	29	13	21	24	**108**
Hampshire Older Drivers – police referral scheme	Service Provision	23	18	17	25	24	**107**
Provision of 'community travel hubs' to encourage use of alternative transport	Communications/ Marketing	24	21	14	25	22	**106**
Older drivers 'Highway Code' - an update for mature drivers - Advice & guidance on: Smart motorways, Speed limits & enforcement, Signs	Guidelines	23	20	18	25	17	**103**

Interventions	Intervention Function	Suitable	Acceptable	Feasible	Extendable	Sustainable	Total Score
& infrastructure, High flow traffic and Changing health & conditions							
Older driver contracts – agreed parameters with family/friends to determine which journeys they can & will make	Guidelines	26	19	16	21	21	**103**
Increase pedestrian crossing time to reduce disincentive to walk	Guidelines	20	20	16	24	22	**102**
Modelling the 'retirement from driving' process to empower children/spouses	Communications/ Marketing	22	20	18	22	19	**101**
Self-assessment tools	Service Provision	29	13	14	23	22	**101**
Explanatory videos on changing highway conditions/rules	Guidelines	21	18	17	26	17	**99**
Vehicle scrappage scheme for over 70's	Environmental/ Social Planning	21	16	12	23	22	**94**
Driving mobility – voluntary referral scheme	Service Provision	23	17	15	18	19	**92**
Free access to public cycle hire schemes	Service Provision	19	19	16	20	16	**90**
Disincentivise maintenance of older vehicle fleet by emphasising higher fuel costs / poor safety features	Environmental/ Social Planning	17	18	15	21	17	**88**
eBike & eScooter hire schemes	Service Provision	17	15	15	23	18	**88**
By creating a new financial instrument that allows older road users to move their investment from owning/maintaining a vehicle into a MAAS platform that minimises the sense of loss that comes with cost per trip products	Environmental/ Social Planning	18	16	12	22	19	**87**
Increase drug analysis for prescription medication	Communications/ Marketing	20	17	12	18	17	**84**
Build narrative into popular media (Emmerdale, Springwatch, Countryfile) about self-regulatory behaviour and use of eBikes	Communications/ Marketing	13	20	12	21	18	**84**

Interventions	Intervention Function	Suitable	Acceptable	Feasible	Extendable	Sustainable	Total Score
GDL for older drivers (voluntary/mandatory)	Guidelines	21	14	11	17	17	**80**
Trials & test-drives of electric mobility scooters	Service Provision	17	15	12	18	14	**76**
Favourable tax regime for active travel infrastructure	Fiscal measures	15	15	10	18	18	**76**
Tax exempt cycle purchase scheme	Fiscal measures	13	15	11	19	17	**75**

Appendix B: Risk Management and Data Storage

Consent Form

The questionnaire was accompanied by a consent form for the participant to sign. It also provided a summary of the way in which confidential information would be handled by the team. The only member of the Agilysis team handling confidential information was the occupational therapist, and they only had access to it for a maximum of seven days. This was required to allow for the NHS referral procedures which would need to be applied if the simulator driving session raised concerns around the participants' driving abilities (with referral to a mobility centre or the DVLA), or when they exhibited symptoms of specific conditions during the assessment sessions (with referral to the participant's GP or a medical specialist). The questionnaire and the consent form were administered in the presence of the occupational therapist. The other Agilysis team member joined the room for the simulator driving session only after the questionnaires and the consent forms were filled in. This way the other team member avoided being biased in their assessment. The therapist reviewed the responses from the questionnaires and gave them to the rest of the team in an anonymised sheet, containing codes for the participants. After any actions had been executed (referring the participant to a GP or assessment centre) the occupational therapist destroyed locally stored data (in the maximum seven days from the time of collection). The consent form was not linked to the questionnaires or the rest of the data, with only the name and the signature of the participants retained on record.

Simulator Sickness

Simulators can cause motion sickness amongst participants, either during or after an assessment session. Classen et al reviewed the literature pertaining to simulator sickness (SS) to inform occupational therapists of symptoms and possible contributing factors (Classen, Bewenitz, & Shechtman, 2011).

> *Early signs of Simulator Sickness (SS) include pallor, restlessness and cold sweat and can progress to nausea, excessive salivating and, finally, vomiting… For people who are susceptible to SS, the effects are cumulative and can include general discomfort, fatigue, headache, eyestrain, difficulty focusing, increased salivation, sweating, nausea, difficulty concentrating, fullness of head, blurred vision, dizziness, vertigo, stomach awareness, or burping*. (Classen, Bewenitz, & Shechtman, 2011)

Classen et al reviewed 10 studies and identified a number of factors which probably contribute to SS symptoms (Classen, Bewenitz, & Shechtman, 2011). These include age and gender, with women and participants over 70 experiencing statistically significantly more SS symptoms than men and those aged 50 and younger. There are also likely to be environmental factors which promote SS, including low refresh rates on the simulator screen; complex visual detail in scenarios; the duration of scenarios; and curves and turns. Mechanical factors can also influence the likelihood of SS occurring, including poor calibration of the mechanical parts of the simulator and the type and configuration of the simulator (with immersive cab-like environments generating more SS than single-desktop or three-screen configurations simulators). Other factors include the participant driving at high speeds or experiencing postural instability (Classen, Bewenitz, & Shechtman, 2011).

Mitigation

1. The trial was designed to attempt to mitigate as many of the environmental factors which can trigger SS as possible. The participant factors of age and gender obviously cannot be removed.
2. The informed consent form asked about participants' history of motion sickness to indicate whether they have suffered previously (asking about travel sickness and other instances of motion sickness). Participants were asked to tell the occupational therapist immediately if they started to feel unwell, resulting in the session being stopped.
3. The assessment sessions were short, providing a screen break between activities, where participants were encouraged to look away from the screen and engage in conversation with the occupational therapist leading the session. These screen breaks were also used to ask questions related to traditional assessment tools.
4. The Simulator Sickness Questionnaire (SSQ) (Kennedy, Lane, Berbaum, & Lilienthal, 1993) was completed at the start of the session and in the breaks to detect any early signs of SS. The session was stopped if any of the items in the SSQ are detected.

Mobility

Given the target age of the participants, some may suffer from reduced mobility. There was a risk that manoeuvring into and out of a simulator could lead to injury or a fall.

Mitigation

The trained occupational therapist produced a risk assessment document, based on the final limitations and requirements of the simulator and the pilot location. The assessment looked at aspects of mobility and accessibility, such as distance to the simulator to and from the door, space in the room, the simulator seat and wheel adaptability, room lighting conditions, etc. At the location, the occupational therapist supported participants in and out of the simulator, as appropriate and necessary.

Detection of undiagnosed conditions

There was a risk that, through observing and talking to participants and/or through the performance in the simulator, suspicions might arise that a participant was suffering from a condition previously undisclosed or undiagnosed.

Mitigation

Following standard NHS procedure, the Occupational Therapist, in agreement with the participant, would follow the existing guidance and write to the participant's GP for further investigation and referral.

Recommendation for driving cessation

There was also a risk that the assessment prompts the occupational therapist to conclude that the participant is not safe to drive.

Mitigation

In such a case, the standard NHS procedure would be followed, which may involve referral to a mobility centre for further assessment, referral to the participant's GP and/or referral to DVLA.

Personal data storage and retention

No personal data will be retained by Agilysis. In order to be able to analyse and correlate data, each participant's data received a code, accompanied with their gender and age. These are the only personal data passed to Agilysis, with the corresponding measurements from the simulator software.

The initial questionnaire data was collected by the occupational therapist, who then summarised the existing conditions, allowing the team of Agilysis to analyse correlations and relations between conditions and driving performance. Also, no Agilysis staff were present in the room with the participant and the occupational therapist when the initial questionnaire and consent form were administrated, in this way avoiding any bias in the driving (in simulator) assessment by awareness of pre-existing conditions. Moreover, this way, no Agilysis team member was involved in the collection of any personal data from the participant. The occupational therapist eventually used the required information for the cases where a referral was necessary, following that (after the process had been concluded), the entire locally stored personal data and information was destroyed.

Test protocols

The tested elements of the project refer to driving abilities and are not subject to risk or specific ethical considerations. The pilot does not include elements subject to:

- Highly sensitive information
- Psychological distress
- Humiliation
- Physical harm or physical exertion
- Substance administration
- Intrusive procedures

Also, no reward or incentive was assumed in the pilot, and no conflicts of interest were documented.

Appendix C: COVID Safety Measures

In order to secure the safety of staff and participants, whilst operating within the current constraints of the coronavirus pandemic, additional protective measures are being implemented.

Venue location

- **Controlled access location**
  The venue will not be a place of open access to the public, participants will have an appointment for their session and staff will control access at all times ensuring only authorised entry.
- **Appropriate furnishings**
  The venue will only be equipped with furnishings that can be easily and routinely cleaned between participant sessions, avoiding the use of items such as chairs with fabric covers.
- **Hand washing**
  Staff will be expected to observe regular handwashing in accordance with government guidelines to reduce any risk of transmission.
- **Hand sanitiser**
  Staff will make hand sanitiser available to participants on both entry to and exit from the venue.

Staff PPE

Staff will be provided with appropriate PPE for the level of engagement with participants that they are expected to have, including the following:

- Face protector
- Face mask
- Gloves

Between clients

Staff will conduct a full clean down of equipment between uses by participants. This will involve the use of clinical grade antibacterial wipes.

As a reminder to all staff the visual guide below will be displayed in the venue:

COVID-19 - Safe Ways of Working
A visual guide:

Appropriate Behaviour

Staff will observe reasonable biosecurity measures in line with government guidance

Protective Equipment

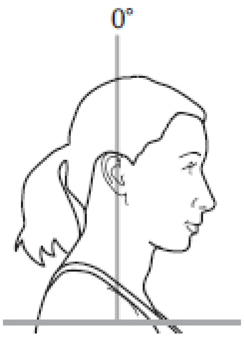
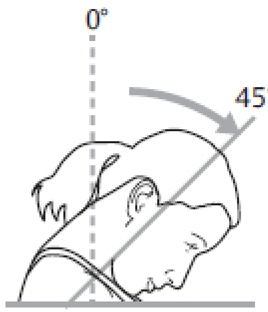
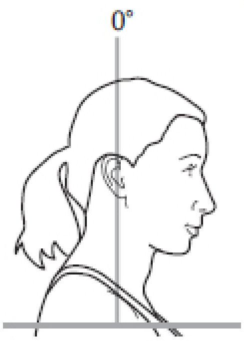
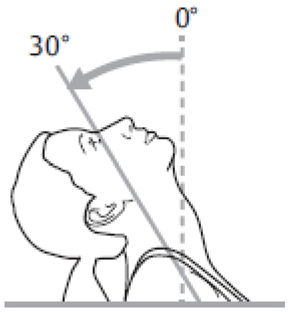
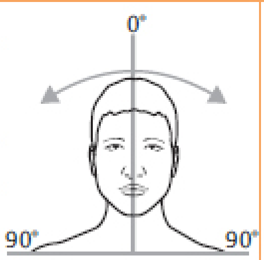
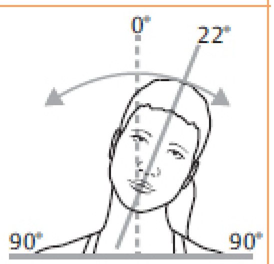
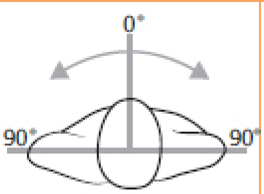
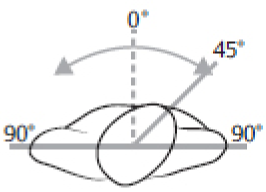
Staff will wear the following PPE when engaging with participants in an enclosed space

Mainting a Safe Environment

Staff will clean down all surfaces and equipment used by participants immediately after use hand sanitiser will be available to participants, before and after any interactions.

Appendix D: Mobility scores

CROM refers to Cervical Range of Motion, as shown in the diagrams below. The table after the diagram shows the scores for participants, with

Normal Range of Movement		
Range of movement	**Neutral position**	**Example**
Flexion		This person has about 45 degrees of flexion. Their chin is less than 1 cm from their sternum. They would appear to have a greater degree of cervical flexion than most people. 
This could be measured in 0–90 degrees from the neutral position.		
Norm = about 38 degrees		
Or, it could be measured crudely in terms of how many centimeters (or inches) the subject's chin is from their sternum.		
Extension		This person has about 30 degrees of extension. Their chin is about 22.5 cm from their chest. This appears to be slightly less than a normal range. 
This could be measured in 0–90 degrees from the neutral position.		
Norm = about 38 degrees		
Or, it could be measured crudely in terms of how many centimeters (or inches) the subject's chin is from their sternum.		
Lateral flexion		In this example, our subject has about 22 degrees of left lateral flexion, less than the norm. 
This could be measured in 0–90 degrees from the neutral position.		
Norm = about 43 degrees		
Or, you could measure crudely how far the client's ear is from their shoulder.		
Rotation		
This could be measured in 0–90 degrees from the neutral position.		
Norm = about 45 degrees		

Subject	Flexion	Extension	Right rotation	Left rotation	Right lateral flexion	Left lateral flexion
						
Mrs. Brown aged 64	30	20	30	25	10	20

Participant IDs	Clinical Frailty Score	Cervical ROM Flexion	Cervical ROM Extension	Cervical ROM right rotation	Cervical ROM left rotation
P10D4	2	39	25	50	48
P10D7	2				
P10D8		45	50	40	45
P10D9	2	48	42	55	48
P11D4	1	30	32	32	35
P11D7	2	43	25	38	40
P11D8	2	38	30	45	52
P12D4	1	48	40	62	52
P12D7		48	18	60	38
P12D8	2	45	25	54	50
P13D8	2	50	25	62	62
P14D8		40	25	40	45
P15D8		46	38	68	55
P1D1		48	42	45	50
P1D2	6	28	18	30	32
P1D3	1	46	44	65	72
P1D4	3	40	35	48	50
P1D5	2	58	29	64	69
P1D6	2	45	30	30	30
P1D7	2	40	40	55	53
P1D8	2	0	0	0	0
P1D9	2	40	49	60	55
P2D2	2	32	28	50	55
P2D3	1	38	38	52	54

Participant IDs	Clinical Frailty Score	Cervical ROM Flexion	Cervical ROM Extension	Cervical ROM right rotation	Cervical ROM left rotation
P2D4	2	40	30	35	40
P2D5	2	45	20	40	34
P2D6	3	43	48	40	40
P2D7	2	42	30	50	45
P2D8	2	0	0	0	0
P2D9	3	44	40	65	63
P3D3	1	30	30	32	34
P3D4	2	52	38	55	56
P3D5	2	39	35	48	20
P3D6	2	50	26	43	45
P3D7	2	50	60	65	70
P3D8	2	45	25	39	46
P3D9	3	45	45	50	30
P4D3	1	36	32	39	35
P4D4	2	60	28	52	45
P4D5	1	52	32	44	58
P4D6	2	49	40	49	60
P4D7	1	35	30	40	35
P4D8	2	35	20	43	39
P4D9	2	30	30	35	35
P5D3	1	37	39	52	55
P5D4	2	53	30	40	46
P5D5	1	52	30	40	60
P5D6	1	48	30	40	40
P5D7	2	49	34	54	55
P5D8	2	55	25	40	45
P5D9	3	28	40	56	54
P6D3		32	28	45	42
P6D4	4				
P6D5		55	29	60	70
P6D6	2	60	25	40	56
P6D7	2	62	40	75	70
P6D8	2	45	43	50	62
P6D9	2	38	26	52	38
P7D3	1	30	30	40	42
P7D4	3	48	30	33	30
P7D5	2	52	26	40	55
P7D6	3				
P7D7	2	45	32	40	40
P7D8	2	48	43	60	50
P7D9	2	48	30	50	45
P8D4	2	51	50	50	50
P8D5	2	40	38	52	56

Participant IDs	Clinical Frailty Score	Cervical ROM Flexion	Cervical ROM Extension	Cervical ROM right rotation	Cervical ROM left rotation
P8D6	3	48	34	50	44
P8D7	3	38	42	46	48
P8D8	3	45	11	35	28
P8D9	2	40	30	35	40
P9D4	4	40	32	55	52
P9D6	2	44	34	65	65
P9D7	2	38	50	62	60
P9D8	2	45	33	50	50
P9D9	2	45	50	50	40

Appendix E: Initial Assessment

MOBILE SIMULATOR TRIAL

Encouraging safe mobility in older drivers through mobile screening

Initial interview

Introduction

I am going to go through a quick survey with you now, it is just to get some information about yourself and your driving. It will help us to understand individual circumstances when analysing the results from the simulator.

I have a few questions about you:

1. Please can you tell me your full name?
   ____
2. And how old are you? ______________
3. Gender: F/M ______________

I am now going to ask you a few questions about driving and your home life.

4. Which of the following best describes your home life?
   a. I live with my spouse/husband/partner
   b. I live with my son/daughter
   c. I live with my son/daughter's family
   d. I live alone
   e. Other. Please describe:
   ____
5. Is your home in a:
   f. Town
   a. City
   b. Rural area
6. How would you describe your personal medical health?
   a. Very good
   b. Good
   c. Not so good
   d. Poor

7. Are you aware of having any ongoing conditions? (YES/NO)

If YES, please tell me what those conditions are:

a. ________________________
b. ________________________
c. ________________________
d. ________________________
e. ________________________

8. How would you describe your vision?
    a. Very good
    b. Good
    c. Not so good
    d. Poor

9. How would you describe your hearing?
    a. Very good
    b. Good
    c. Not so good
    d. Poor

Driving related questions:

10. Which one of the following statements best describes how often you drive?
    a. I am driving daily
    b. I am driving every other day
    c. I am driving weekly
    d. I am driving monthly
    e. Other: _________________________

11. What is your average weekly distance travelled driving?
    a. Up to 20 miles__
    b. 20 to 50 miles__
    c. 50 to 100 miles__
    d. 100 to 250 miles__
    e. Over 250 miles__

12. How often do you drive in the following situations?

a.	In daylight	__Always__Mostly__Rarely__Never
b.	At night	__Always__Mostly__Rarely__Never
c.	In wet weather	__Always__Mostly__Rarely__Never
d.	On rural roads	__Always__Mostly__Rarely__Never
e.	On motorways	__Always__Mostly__Rarely__Never
f.	On dual carriageways	__Always__Mostly__Rarely__Never
g.	On familiar routes	__Always__Mostly__Rarely__Never
h.	On new routes	__Always__Mostly__Rarely__Never

13. Are you driving accompanied?
    a. Only accompanied__
    b. Mostly accompanied__
    c. Mostly unaccompanied__

d. Only unaccompanied__

14. How do you usually access your car?
    a. Roadside__
    b. Steps__
    c. Uneven path__
    d. Gravel drive__
    e. Level drive__

15. Are there any other things you would like to mention about your health, mobility or driving (such as near misses, falls or aid required)?

____
____
____

16. Are you currently taking any medication? (YES/NO)

If YES, please tell me what medication you are taking

a. ________________________
b. ________________________
c. ________________________
d. ________________________
e. ________________________

Appendix F: Participant Information Sheet

Encouraging safe mobility in older drivers through mobile screening

Introduction

You are invited to take part in a research study. Before you decide, you need to understand why the research is being done and what it would involve for you. Please take the time to read the following information carefully.

What is the study about?

This study is design to understand how practical and meaningful is to deliver older driving screening assessment using a mobile simulator.

What is the background to this study?

Research has demonstrated the viability of utilising relatively low cost, portable simulator rigs for testing physical conditioning and impairment, and the potential exists to extend this as a mechanism for screening. There is growing confidence that a viable screening assessment could be delivered using such a mechanism and to test this in a UK context. The research team wrote a paper for the Department for Transport in 2019 looking at ways to assist the older driving population to maintain their mobility into later life. This project takes forward one of the recommended solutions: a driving simulator check.

What is the aim of the study?

- To assess if the simulator tests provide a meaningful assessment of abilities which impact on drivers' collision risk
- To assess if simulator tests are feasible to deliver
- To assess if the simulator tests are acceptable to older drivers, identifying the fears and barriers encountered by older drivers
- To assess if the simulator tests are more acceptable to clinicians than traditional assessment methods

Do I have to take part?

Your participation in this study is voluntary.

What are the possible benefits of taking part?

By choosing to take part, you will receive a dedicated check with a trained clinician and using cutting edge simulator technology. Our staff will talk through any mobility difficulties you might be experiencing, concerns about your health and guide you to find relevant support (if necessary) after you have completed your check. There is no risk to your licence, only help and advice from our team and you will help us to design solutions that can keep people mobile into later life.

How long does a session last?

Each session will last approximately 40 minutes. We will use some of this time to discuss your normal driving habits and health, and up to half of the time will be spent in the simulator practicing a number of different driving scenarios.

What is happening during the session?

Our team will ask you some questions to make sure that you are comfortable to continue and take part in the study and they will ask you some questions about your driving, mobility needs and general health. You will then be given the opportunity to do a range of driving tasks in the simulator.

What will happen when the study ends?

The study will result in a research report which will be submitted to the Department for Transport and other agencies working in transport, health and older people's services. We trust that this will help to shape future provision to keep citizens independent and mobile into later life.

We will retain the anonymised data, in case there is a need to analyse further, however, all personal details will have been removed from our system. If you would like to receive a digital copy of the research when it is concluded, we will provide you with an opportunity to sign up and receive a copy.

What about Coronavirus?

Naturally, we are taking the current situation with Coronavirus very seriously, and following all reasonable precautions to provide protection for you and our staff.

- In accordance with government guidelines on wearing masks in shops, we would ask you to please wear a face covering as well; unless you are exempt from the need to wear one.
- We will endeavour to maintain social distancing throughout, except where assistance is required in and around the simulator.
- The team will have face shields and gloves to limit their contact and exposure.
- Hand sanitiser will be provided and a strict regime of wiping down all surfaces with clinical grade wipes will be observed between all participants.

What if you don't feel comfortable in the simulator?

Sometimes people do not find using the simulator comfortable experiencing something akin to travel sickness. If you start to feel uncomfortable at any point, please speak to one of the team immediately and they pause or end the driving task.

Are the team qualified?

Our team includes experienced researchers who work on major research programmes in the UK and abroad, and a fully qualified Occupational Therapist with over 20 years' experience working with older people. They have been trained in the use of the simulator and are also DBS checked.

What information will we collect?

We will collect your name and contact details, which will use to contact you about your appointment. We will also ask you some questions about your driving, mobility needs and general health.

What will we do with your information?

We will contact you to confirm that you have an appointment booked, and to send a link to a follow-up survey to ask you how you found the experience and whether you have done anything differently since taking part. Your personal data will only be stored on our system long enough for us to make contact with you for these purposes.

Any data relating to your health, driving or mobility needs will be anonymised, so there will be no way of anyone associating this back to you. We will not pass on your details to any other agency unless a significant health concern arises for which we would need to advise your GP. We will, of course, discuss this with you.

What will happen if I don't want to carry on being part of the study?

Your participation in this study is voluntary and you are free to withdraw at any time, without giving any reason.

What if there is a problem or I wish to make a complaint?

If there is any problem on the day, please notify our staff immediately and they will take every step to try and ensure that it is rectified. If there is anything that cannot be dealt with on the day, please write to Simulator Research, Agilysis, 27 Horse Fair, Banbury, OX16 0AE or email info@roadsafetyanalysis.org and it will be passed to our Head of Research for immediate review.

Who can I contact for more information?

For more information, please email info@roadsafetyanalysis.org or call 01295 731810 and we will arrange for someone to speak with you.

Appendix G: Consent Form

mobile SIMULATOR TRIAL

Encouraging safe mobility in older drivers through mobile screening

Name of researcher:	
Name of participant:	

	Initials
I confirm that I have read and understand the information sheet dated for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.	
I understand that my name will not appear in any reports, articles or presentations.	
I consent for my personal data to be collected for the purpose of the study and stored for a period of maximum 21 days.	
I consent that the data collected from the simulator to be used for the purpose of the study, anonymised.	
I agree to take part in the above study.	

Signature of participant:	
Signature of researcher:	
Date	

Appendix H: Recruitment

The research team employed a multi-strand recruitment strategy in order to attract participants to the study. Without the opportunity to work through primary care providers, there was no direct route to participants, forcing the team to look to more creative ways to attract the local population within the target demographic and secure sufficient participation.

Letters to GPs

In seeking to facilitate the study being as faithful to the original design as possible, the team reached out to all GP practises within a 10-mile radius of Banbury. Letters invited GPs to encourage appropriate patients to sign up online for this driver's check.

Local Editorial

To reinforce recruitment through the primary healthcare system the team also ran an editorial piece in the local newspaper providing details on the study and how people could participate at the location of the pop-up shop being used in the Castle Quay shopping centre.

Connecting with Local Groups

In order to reach the widest possible population of local older citizens the research team also reached out to local support groups working with older people. The chairman of Banbury Evergreens, a local support group with around 200 members, was particularly supportive in providing details of the study to their members.

Advertising in Store

The prime retail site selected for the study also provided a significant opportunity for advertising. Launch format graphic panels (see Appendix J: Promotional Material) were installed in the front windows to the pop-up shop advertising the study and the dates on which participants could be included. Links to the website for online booking were also provided.

Online Advertising

Social media advertising, particularly through Facebook, was also pursued in the run up to the pilot study. This allowed the research team to reach out to all active Facebook users in the Banbury area who reported being the relevant age.

Direct Recruitment

Finally, using the presence of the pop-up shop in a high footfall retail environment, the research team made contact with passers-by who appeared to fit the target demographic issuing leaflets (see Appendix J: Promotional Material) and encouraging them to book online. In some cases, enthusiastic participants requested to be fitted in during this same visit to the shopping centre, these requests were accommodated where possible.

Online Booking System

Participant management was initially through an online booking portal that was hosted at roadsafetyanalysis.org. The website included significant detail for participants on the nature of the study, its supporters and what participants could expect from taking part. A series of booking slots were made available for each day allowing participants to select and book a time convenient to them.

Appendix I: Risk Assessment

Agilysis - Risk Assessment Form

Activity: Simulator Study | Updated: 30/09/2020

			Latent Risk					Managed Risk			
Hazards	Consequences	Who is at risk	Probablity	Severity	Risk	Action Level	Controls	New Probablity	New Severity	New Risk	Rating
Working with vulnerable person	Incident with vulnerable person or accusation against a staff member	Staff / Participants	1	3	3	Moderate	Staff will be subject to the safeguaring policy for working with young or vulnerable people. DBS checks will be undertaken for all staff in line with this.	1	2	2	Tolerable
Lifting for Set-up	Lifting equipment	Staff / Partners	2	1	2	Tolerable	Heavy/awkward equipment lifting should involve two people where necessary. Plan safe clear route for moving. All staff trained on safe lifting. Delivery of simulator managed by logistics copany	1	1	1	Minimal
Inproper Social Distancing (COVID-19)	Transmition of COVID-19 between participants	Staff / Partners / Participants / Public	2	2	4	Moderate	All staff and contractors will be reminded to maintain safe social distancing in line with current government advice. Floor markings and any seating appropriately spaced at 2m This will be relayed to members of the public who fail to observe the minimum social distance.	1	2	2	Tolerable
Face touching, Sneezes, spittle	Transmition of COVID-19 between staff or participants	Staff / Partners / Participants / Public	2	2	4	Moderate	Staff and participants will be required to wear protective fask masks or coverings.	1	2	2	Tolerable
Contact with objects and surfaces (COVID-19)	Transmition of COVID-19 between participants	Staff / Partners / Participants / Public	3	2	6	Substantial	A All surfaces and objects where people have come in contact, will be cleaned with anti-bacterial wipes before use by another person. Antibacterial gel will be recomended to all participants before and after interaction. Gloves will be used by staff. Any chairs for waiting participants will be wiped down.	2	2	4	Moderate
Wearing lanyards	Injury to user if caught up on something or if pulled by someone	Participants / Staff / Partners	1	1	1	Minimal	Break free clip lanyards to be used	1	1	1	Minimal
Large Digital Displays	Lifting equipment. Falling and injuring somebody	Staff / Public	2	1	2	Tolerable	Screens should be lifted using two people and should be securely fastened to the stand. Screen and stand to be set at the rear of room to reduce the chance of people knocking it over. Participants to leave sufficient room between themselves and TV, staff member and participant in simulator	2	1	2	Tolerable
Power cables to simulator, laptops and TV constitute a trip hazard	Fall-related injury, potentially requring hospital treatment	Participants / Staff / Partners	2	1	2	Tolerable	No cables will extend into trafficked areas. Wires will be taped to the floor or covered with appropriate cable coverings.	2	1	2	Tolerable

Spills & Slippage	Falls as a result of slipping on drink spills at the event.	Staff / Public	2	1	2	Tolerable	Absorbant paper towels or similar to be provided to mop up large volumes of spilled fluids. Staff refreshments to be taken away from the 'shop floor' Waste bags or bins provided to manage other waste.	2	1	2	Tolerable
Falls risk	Falls as a result of reduced mobility and complex comorbidities.	Public	1	2	2	Tolerable	Consider the environment i.e. is the area clear and free from any obstacles. Be aware of fixed furnishings. Does the participant have a fear of falling or history of falls? Do they normally use a mobility aid or mobilise A01. Determine auditory and visual acuity. If high falls risk OT to guide and assit throughout Ax. Ensure participant can follow verbal commands.	1	2	2	Tolerable
Accessing car seat (limited access of 33 cm - 38cm)	Unsafe transfer resulting in injury	Staff/public	2	2	4	Moderate	Assessment of dynmic standing balance. In light of initial mobility & transfer Ax advise re: car transfer techniques and assist where appropriate. Adjust the car seat to allow full leg clerance (narrow at 38cm) ensuriing sufficent antigravity leg extensor power. Determine dynamic sitting balance prior to transfer and ensure they can follow verbal instructions.Use swivel cushion where appropriate.	1	2	2	Tolerable
Medical event e.g vasovagal syncope	Detrimental to participants health, high stress for participant, accompaniying relatives/friends and the assessors.	Staff/Public	1	3	3	Moderate	High risk conditions and correlated risk identified within the initial interview E.G high/low blood pressure/Stroke/COPD. Clear explaintion of task with regular opportunities to ask questions and stop activity. Reasurance from health professional. Clinical reasoning and observation alerting health practitioner to any risk e.g. sweaty, clammy, dyspnea, vacant, delayed response. Appropriate intervention to curtail risk e.g active breathing techniques. Termination of task if participant exhibits any symptoms.	1	2	2	Tolerable
Simulator sickness	Vomitting - detrimental to participants health, high stress for participant, accompaniying relatives/friends and the assessors. High COVID infection risk with aerosol generation and bodily fluids.	Staff/Public	3	1	3	Moderate	Appropriate use of PPE, regular screen breaks, use of the Simulator Sickness Questionnaire (SSQ). Termination of task when SSQ alerts are identified.	2	1	2	Tolerable

Appendix J: Promotional Material

Figure 3: Signage in store was erected prior to the pilot study to encourage participants to book online

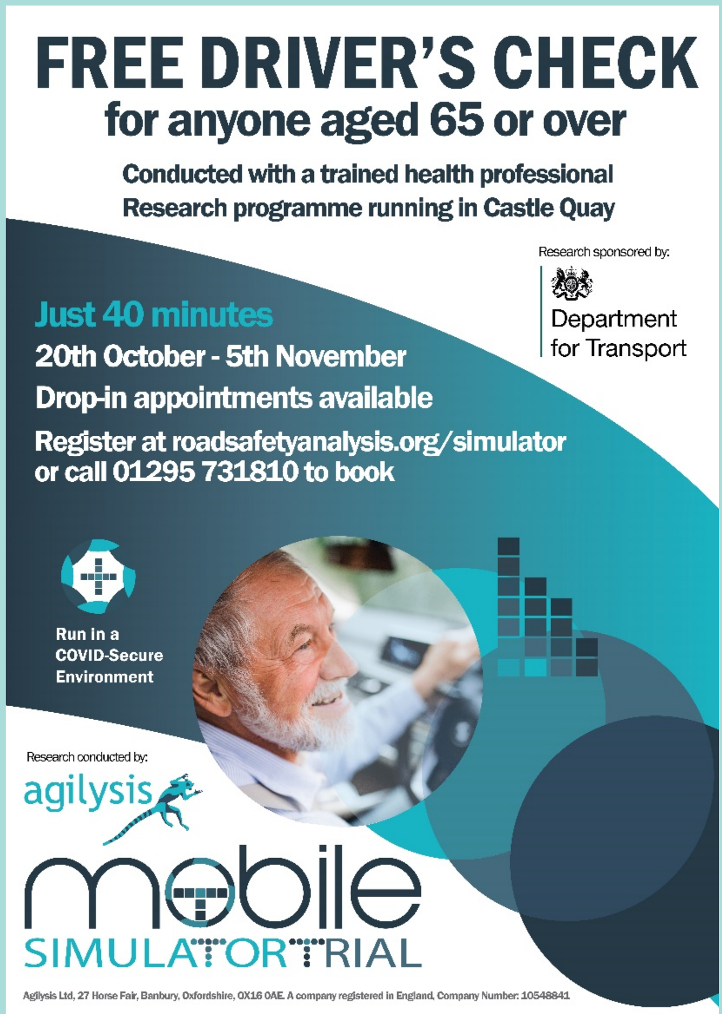


Figure 4: Flyer used to attract shopping centre patrons

Appendix K: Introductory Video

Figure 5: The introductory explanatory video ([viewable here]()) was played to participants to reinforce information about the study

Appendix L: Demographic summary

Pilot participants

Table 3 - Gender and age of pilot participants

Gender	Number of participants	Min of Age	Max of Age
F	3	72	76
M	7	60	86
Grand Total	**10**	**60**	**86**

Table 4 - Home life of pilot participants

Home Life			
Gender	**I live with my spouse/husband/partner**	**I live alone**	**Grand Total**
F	2	1	3
M	4	3	7
Grand Total	**6**	**4**	**10**

Table 5 - Home location of pilot participants

Home Location			
Gender	**Town**	**Rural area**	**Grand Total**
F	3		3
M	3	4	7
Grand Total	**6**	**4**	**10**

Table 6 - Self-reported personal health of pilot participants

Personal Health				
Gender	**Very good**	**Good**	**Not so good**	**Grand Total**
F	2	1		3
M	3	3	1	7
Grand Total	**5**	**4**	**1**	**10**

Table 7 - Self-reported vision of pilot participants

Vision			
Gender	**Very good**	**Good**	**Grand Total**
F	3		3
M	1	6	7
Grand Total	**4**	**6**	**10**

Table 8 - Self-reported hearing of pilot participants

Hearing			
Gender	**Very good**	**Good**	**Grand Total**
F	3		3
M	3	4	7
Grand Total	**6**	**4**	**10**

Table 9 - Driving frequency of pilot participants

Driving frequency				
Gender	**Driving daily**	**Driving every other day**	**Other:**	**Grand Total**
F		2	1	3
M	3	2	2	7
Grand Total	**3**	**4**	**3**	**10**

Table 10 - Weekly distance of pilot participants

Weekly distance				
Gender	**Up to 20 miles**	**20 to 50 miles**	**50 to 100 miles**	**Grand Total**
F	1	1	1	3
M	2	3	2	7
Grand Total	**3**	**4**	**3**	**10**

Table 11 - Driving patterns of pilot participants

Driving accompanied			
Gender	**Mostly accompanied**	**Mostly unaccompanied**	**Grand Total**
F	2	1	3
M	2	5	7
Grand Total	**4**	**6**	**10**

Main programme participants

Table 12 – Gender and age of main programme participants

Gender	Number of participants	Average of Age	Min of Age	Max of Age
F	21	71.62	65	78
M	45	73.55	56	91
Grand Total	**66**	**72.92**	**56**	**91**

Table 13 - Home life of main programme participants

Home Life					
Gender	**I live with my spouse/husband/partner**	**I live with my son/ daughter**	**I live alone**	**Other**	**Grand Total**
F	11	3	7		21
M	35		9	1	45
Grand Total	**46**	**3**	**16**	**1**	**66**

Table 14 - Home location of main programme participants

Home Location				
Gender	**Town**	**City**	**Rural area**	**Grand Total**
F	13	1	7	21
M	28		17	45
Grand Total	**41**	**1**	**24**	**66**

Table 15 - Self-reported personal health of main programme participants

Personal Health Gender	Very good	Good	Not so good	Poor	Blank	Grand Total
F	9	10			2	21
M	17	23	4	1		45
Grand Total	**26**	**33**	**4**	**1**	**2**	**66**

Table 16 - Self-reported vision of main programme participants

Vision Gender	Very good	Good	Not so good	Blank	Grand Total
F	11	7	2	1	21
M	25	20			45
Grand Total	**36**	**27**	**2**	**1**	**66**

Table 17 - Self-reported hearing of main programme participants

Hearing Gender	Very good	Good	Not so good	Blank	Grand Total
F	14	6	1		21
M	26	13	5	1	45
Grand Total	**40**	**19**	**6**	**1**	**66**

Table 18 - Driving frequency of main programme participants

Driving frequency Gender	Driving daily	Driving every other day	Driving twice/ week	Driving weekly	Driving monthly	Grand Total
F	6	2	9		4	21
M	24	9	9	3		45
Grand Total	**30**	**11**	**18**	**3**	**4**	**66**

Table 19 - Weekly distance of main programme participants

Weekly distance Gender	Up to 20 miles	20 to 50 miles	50 to 100 miles	100 to 250 miles	Over 250 miles	Blank	Grand Total
F	6	9	4	1		1	21
M	4	9	16	12	2	2	45
Grand Total	**10**	**18**	**20**	**13**	**2**	**3**	**66**

Table 20 - Driving patterns of main programme participants

Driving accompanied Gender	Mostly accompanied	Mostly unaccompanied	Only unaccompanied	Fifty-fifty	Blank	Grand Total
F	4	9	2	6		21
M	15	7	3	19	1	45
Grand Total	**19**	**16**	**5**	**25**	**1**	**66**

Appendix M: Results

Pilot

The following tables summarise the results of the hazard perception scenarios tested in the pilot phase.

Table 21 - Duration, speed and braking of daytime hazard perception

Hazard Perception Daytime (HD) Gender	Number of participants	Average of HD total duration	Average of HD average speed	Average of HD max speed	Average of HD total braking time
F	3	210.94	10.44	25.11	14.46
M	7	204.43	14.43	31.97	13.11
Grand Total	**10**	**206.38**	**13.24**	**29.91**	**13.52**

Table 22 - Indication and horn time for hazard perception scenario

Participant Key	Average of HD total indicating time	Average of HD total horn time
F	**50.82**	**1.40**
P5D3	40.40	0.90
P6D3	48.49	1.46
P7D3	63.57	1.84
M	**28.69**	**1.45**
P1D1	0.00	0.08
P1D2	63.15	2.85
P1D3	48.11	2.22
P2D2	46.01	1.21
P2D3	0.00	0.09
P3D3	43.60	2.33
P4D3	0.00	1.37
Grand Total	**35.33**	**1.43**

Table 23 - Junction duration, average speed and indicating time

Junction	Average of HD junction duration	Average of HD junction average speed	Average of HD junction indicating time
Junction 1	0.82	8.20	0.64
Junction 2	1.79	7.18	1.45

Table 24 - Average hazard duration per hazard

Average hazard duration Participant key	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
F	**1.89**	**4.92**	**4.45**	**2.93**	**1.47**	**1.16**	**1.20**
P5D3	1.36	4.28	3.85	1.53	1.04	0.85	0.74
P6D3	1.85	5.06	4.51	3.97	1.81	1.37	1.00
P7D3	2.45	5.42	4.99	3.29	1.55	1.26	1.85
M	**1.71**	**3.13**	**3.49**	**2.64**	**0.98**	**0.90**	**0.78**
P1D1	1.60	2.63	3.23	1.41	0.66	1.16	0.58
P1D2	3.00	4.55	6.02	4.31	1.78	0.96	1.14
P1D3	1.17	1.99	1.89	3.65	0.73	0.92	1.22
P2D2	2.31	1.96	2.76	1.34	0.73	0.79	0.89
P2D3	1.36	2.39	0.00	0.00	0.00	0.00	0.00
P3D3	1.25	3.92	8.00	4.23	1.29	1.35	1.06
P4D3	1.29	4.44	2.55	3.56	1.65	1.15	0.54
Grand Total	**1.76**	**3.66**	**3.78**	**2.73**	**1.13**	**0.98**	**0.90**

Table 25 - Average hazard speed per hazard

Average hazard speed Participant key	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
F	**11.40**	**10.39**	**8.76**	**8.36**	**14.54**	**18.33**	**19.80**
P5D3	14.96	11.44	9.22	13.38	19.44	24.17	27.75
P6D3	10.97	9.92	9.13	5.32	11.19	14.81	20.48
P7D3	8.27	9.81	7.93	6.37	12.98	16.00	11.18
M	**13.14**	**14.30**	**11.12**	**9.23**	**20.83**	**19.92**	**25.14**
P1D1	12.71	17.56	10.86	18.74	30.17	17.45	35.08
P1D2	6.72	9.67	5.06	4.78	11.24	21.35	17.91
P1D3	17.14	18.24	18.72	5.71	28.12	22.06	16.87
P2D2	8.79	17.33	13.69	15.61	27.69	25.88	23.02
P2D3	14.78	16.75	-	-	-	-	-
P3D3	16.28	11.42	4.56	4.80	15.52	15.18	19.37
P4D3	15.57	9.16	13.85	5.76	12.25	17.60	38.60
Grand Total	**12.62**	**13.13**	**10.34**	**8.94**	**18.73**	**19.39**	**23.36**

Table 26 - Average braking time per hazard

Average hazard braking time Row Labels	Man walks around truck	Car emerging from driveway	Truck turning into junction
F	**0.05**	**0.00**	**0.00**
P5D3	0.00	0.01	0.00
P6D3	0.00	0.00	0.00
P7D3	0.16	0.00	0.00
M	**0.07**	**0.31**	**0.59**
P1D1	0.00	0.00	1.32
P1D2	0.48	0.00	0.00
P1D3	0.00	0.00	1.02
P2D2	0.00	0.27	0.00
P2D3	0.00	0.00	0.00
P3D3	0.00	1.91	1.77
P4D3	0.00	0.00	0.00
Grand Total	**0.06**	**0.22**	**0.41**

Table 27 - Average horn use time per hazard

Average hazard horn use time Participant key	Man walks around truck	Car emerging from driveway	Truck turning into junction
F	**0.08**	**0.10**	**0.12**
P5D3	0.00	0.00	0.00
P6D3	0.12	0.21	0.37
P7D3	0.13	0.10	0.00
M	**0.00**	**0.13**	**0.05**
P1D1	0.00	0.00	0.00
P1D2	0.00	0.40	0.00
P1D3	0.00	0.00	0.00
P2D2	0.00	0.14	0.00
P2D3	0.00	0.00	0.00
P3D3	0.00	0.35	0.38
P4D3	0.00	0.00	0.00
Grand Total	**0.02**	**0.12**	**0.07**

Table 28 – Average indicating time per hazard

Average hazard indicating time Participant key	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb
F	**2.35**	**1.83**	**0.00**
P5D3	1.06	1.53	0.00
P6D3	4.51	3.97	0.00
P7D3	1.49	0.00	0.00
M	**1.72**	**1.93**	**0.00**
P1D1	0.00	0.00	0.00
P1D2	3.50	4.31	0.00
P1D3	1.89	3.65	0.00
P2D2	2.76	1.34	0.00
P2D3	0.00	0.00	0.00
P3D3	3.88	4.23	0.00
P4D3	0.00	0.00	0.00
Grand Total	**1.91**	**1.90**	**0.00**

Main Study

Observational notes on driving behaviour

- P1D4 – missed the turn, did not finish all the scenarios
- P2D4 – took wrong turn, disoriented, did not complete most of the tasks
- P10D4 – misinterpreted the instructions, did not finish the scenarios
- P11D4 – low speed, multiple unnecessary stops, high variability in speed
- P5D5 – unusually slow around some hazards
- P8D5 – overconfident, high speed, missing hazards
- P6D6 – insecure with the braking, weak control of the vehicle
- P2D7 – high speed night session
- P6D8 – overconfident, disregards instructions
- P9D8 – low speed night-time, possible visual impairment
- P11D8 – low speed, lack of confidence
- P5D9 – misinterpreted the instructions, low speed, insecure

Free drive

Table 29 - Duration, speed and braking of free drive session

Free Drive Gender	Number of participants	Average of FD total duration	Average of FD average speed	Average of FD max speed	Average 85th percentile (speed)	Average total indicating time	Average of FD total braking time
F	21	264.51	27.44	55.04	45.86	32.25	6.61
M	45	216.99	43.17	70.25	64.00	9.80	4.88
Grand Total	**66**	**229.50**	**39.03**	**66.25**	**59.23**	**15.71**	**5.33**

Correlation: Average speed – Age

X Values
∑ = 4740
Mean = 71.818
∑ (X - Mx)2 = SSx = 7787.818

Y Values *(Average speed)*
∑ = 2224.66
Mean = 33.707
∑ (Y - My)2 = SSy = 27618.533

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = -2889.496

R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = -0.197
Meta Numeric (cross-check)
r = -0.197

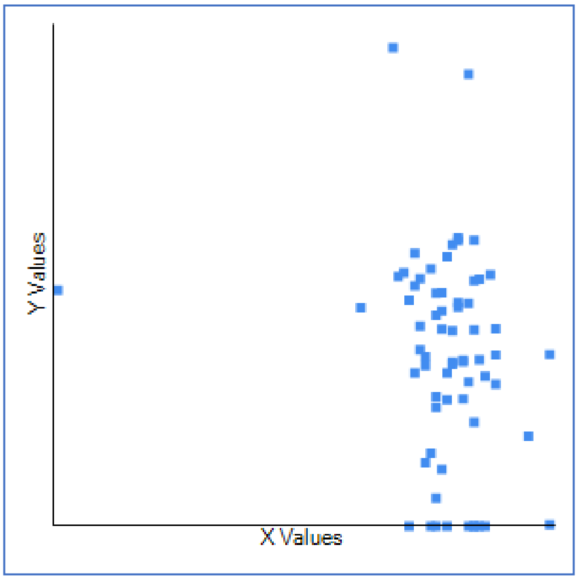


Figure 6 - Average speed by age for free drive

Although technically *a negative correlation*, the relationship between the variables is *only weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .112867. The result is **not significant** at p < .05.

Correlation: Average speed – Weekly driving distance

X Values *(Weekly driving distance: Up to 20 miles = 1; 20 to 50 miles = 2; 50 to 100 miles = 3; 100 to 250 miles = 4; Over 250 miles = 5)*
∑ = 168
Mean = 2.545
∑ (X - Mx)2 = SSx = 92.364

Y Values *(Average speed)*
∑ = 2224.66
Mean = 33.707
∑ (Y - My)2 = SSy = 27618.533

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 429.499

R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.2689
Meta Numeric (cross-check)
r = 0.2689

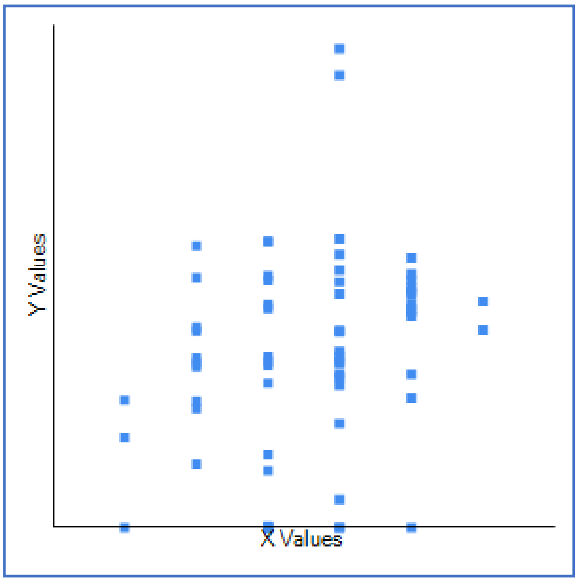


Figure 7 - Average speed by weekly driving distance for free drive

Although technically *a positive correlation*, the relationship between the variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .029021. The result is **significant** at p < .05.

Correlation: Average speed – Driving frequency

X Values *(Driving frequency: Monthly = 1; Weekly = 2; Twice a week = 3; Every other day = 4; Daily = 5)*
∑ = 258
Mean = 3.909
∑ (X - Mx)2 = SSx = 95.455

Y Values *(Average speed)*
∑ = 2224.66
Mean = 33.707
∑ (Y - My)2 = SSy = 27618.533

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 261.052

R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.1608
Meta Numeric (cross-check)
r = 0.1608

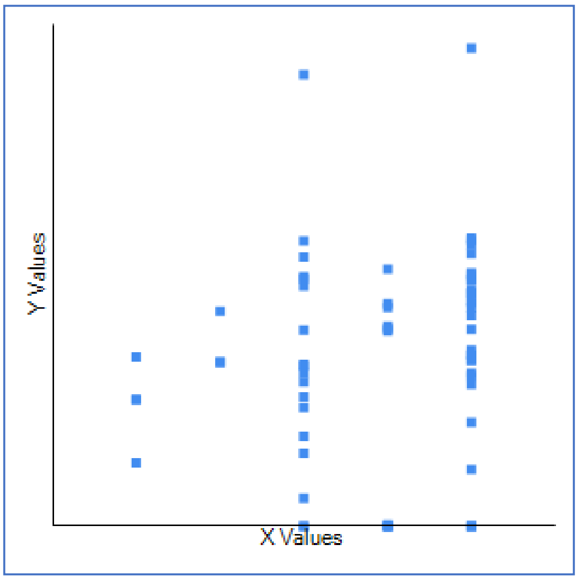


Figure 8 - Average speed by driving frequency for free drive

Although technically *a positive correlation*, the relationship between the variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .197121. The result is **not significant** at $p < .05$.

Emergency Braking

Table 30 - Duration, speed and braking of emergency braking scenario

Emergency Braking Gender	Number of participants	Average of EB total duration	Average of EB average speed	Average of EB max speed	Average of EB 85th percentile	Average of EB total braking time
F	21	45.84	16.79	30.71	30.06	5.11
M	45	46.49	16.95	30.39	29.61	6.62
Grand Total	**66**	**46.34**	**16.91**	**30.47**	**29.71**	**6.26**

Average speed – frequency histogram – female participants

As we can observe, only 13 female participants have their average speed recorded for the scenario. Nevertheless, the distribution is fairly centred, with the vast majority of the values ranging between 15.8 and 17.8 MPH.

The lowest average speed is 13.84 MPH and the highest is 21.12 MPH. The high number of missing values (8 missing out of 21 participants) indicate a problem either in the recording of the session, in the delivery or the session was terminated.

The standard deviation is 1.75 MPH with a total distribution range of 7.28 MPH.

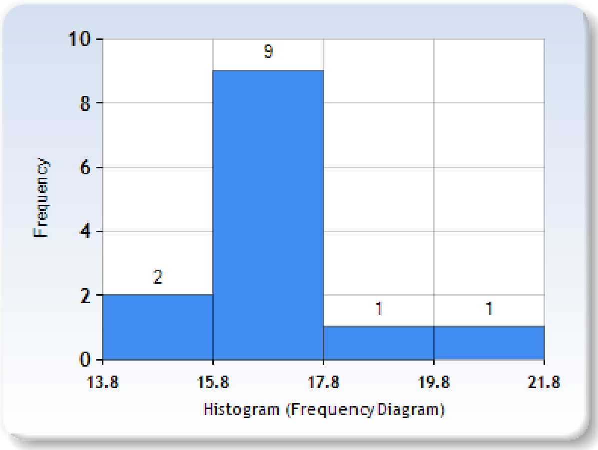


Figure 9 - Average speed for female participants for emergency braking

Table 31 – Average speed data for female participants for emergency braking

Female Average Speed Histogram	
Mean	16.78538
Standard Deviation (s)	1.75074
Skewness	1.16883
Kurtosis	2.77581
Lowest Score	13.84
Highest Score	21.12
Distribution Range	7.28
Total Number of Scores	13
Number of Distinct Scores	13
Lowest Class Value	13.8
Highest Class Value	21.79
Number of Classes	4
Class Range	2

Average speed – frequency histogram – male participants

A higher proportion of male participants have their average speed value recorded (42 out of 45), compared to female participants (13 out of 21). The distribution of the values is more skewed toward right (higher speeds), but the distribution range is higher than for female participants (12.68 MPH compared to 7.28 MPH). Also, for male participants, the standard deviation is higher compared to female participants, which again means that the distribution is in general spread more widely. The lowest average speed recorded was 8.88 MPH and the highest average speed was 21.56 MPH.

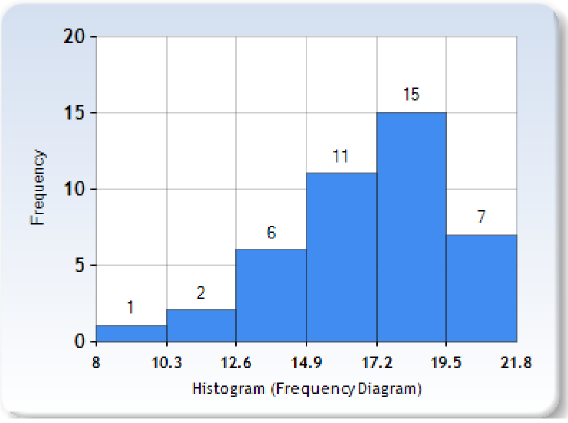


Figure 10 - Average speed for male participants for emergency braking

Table 32 - Average speed data for male participants for emergency braking

Male Average Speed Histogram	
Mean	16.95548
Standard Deviation (s)	2.76076
Skewness	-0.91495
Kurtosis	1.04309
Lowest Score	8.88
Highest Score	21.56
Distribution Range	12.68
Total Number of Scores	42
Number of Distinct Scores	41
Lowest Class Value	8
Highest Class Value	21.79
Number of Classes	6
Class Range	2.3

Thinking about the cut-off points for flagging outlying behaviour, the mean and the standard deviation can be used to flag behaviours that fall far from the sample mean. Using the empirical rule 68-95-99.7[3], it is expected that the following should be identified:

A) The 32% furthest away from the distribution centre within one standard deviation from the mean => (16.95548 -/+ 2.76076) => (14.19; 19.72)
B) <u>The 5% furthest away from the distribution centre within two standard deviations from the mean => (11.43; 22.48)</u>
C) The 0.3% furthest away from the distribution centre within three standard deviation from the mean => (8.67; 25.24)

In practice, option B is the most commonly used, identifying the 5% furthest away outliers. For average speed of male participants, they are represented by the participants with average speeds outside the interval (11.43; 22.48). From the data, we identified P11D8 = 8.88MPH, and P15D8 = 10.48MPH. These participants can be flagged for unusually low speeds.

Calculating the corresponding interval for female participants, the interval (13.28 – 20.29) is obtained. From the data, participant P11D7 = 21.12 MPH can be flagged as having an unusually high speed.

Average speed – frequency histogram – all participants

As the differences between male and female, on average, are not significant, the entire population can be considered together to create distribution values for the whole sample. The hazard perception scenario still needs to be investigated to understand if the distribution between the two genders is fully comparable.

Table 33 - Average speed data for all participants for emergency braking

All participants Average Speed Histogram	
Mean	16.91527
Standard Deviation (s)	2.54428
Skewness	-0.77562
Kurtosis	1.32318
Lowest Score	8.88
Highest Score	21.56
Distribution Range	12.68
Total Number of Scores	55
Number of Distinct Scores	54
Lowest Class Value	8
Highest Class Value	21.79
Number of Classes	6
Class Range	2.3

[3] https://www.learner.org/wp-content/uploads/2019/03/AgainstAllOdds_StudentGuide_Unit08-Normal-Calculations.pdf

As can be observed, for the entire distribution, the mean value is 16.92 MPH, with a standard deviation of 2.54 MPH, a total range of 12.68 MPH. 8.88 MPH is the lowest average speed recorded, and 21.56 MPH is the highest one. The interval for detecting the 5% furthest outliers is (11.83; 22.00). For these new values, there are three participants identified in the data: P11D4 = 11.51, P11D8 = 8.88MPH, and P15D8 = 10.48MPH. It can be observed that the two outliers identified for the male sample are still present, to which another participant (also male) is added, but as the range has increased, the high-end outlier from the female sample is not considered an outlier anymore. The decision whether to separate the male and female samples has to come after more analysis and should be based on the insight that the two samples are behaving similarly or exhibiting significant differences. Also, it is possible that the two samples can be analysed together for certain variables and separately for others, according to their behaviour.

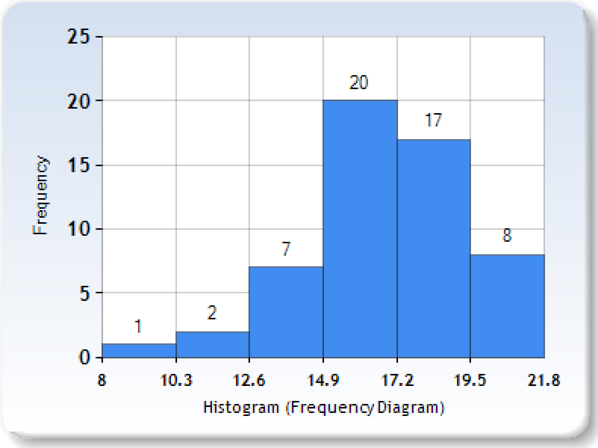


Figure 11 - Average speed for all participants for emergency braking

For ease of presentation and interpretation, the following analysis will present male, female and overall samples in a comparative table, adding the corresponding intervals at the end, and the identified outliers.

Average braking – frequency histogram – all participants

The team has initially identified an aberrant data point, which was eliminated from the analysis, to avoid skewing the results.

Table 34 - Average braking time data for all participants for emergency braking

Average Braking Time Histogram			
	All participants	Male participants	Female participants
Mean	5.70333	5.10692	5.89244
Standard Deviation (s)	2.88062	2.05311	3.09483
Lowest Score	2.05	2.81	2.05
Highest Score	15.8	9.55	15.8
Distribution Range	13.75	6.74	13.75
Total Number of Scores	54	13	41
Number of Distinct Scores	52	13	40
Low 95% interval	0.00	1.00	0.30
High 95% interval	11.46	9.21	12.08
Outliers	P15D8 = 15.80; P5D9 = 12.60; P6D6 = 12.94	P9D7 = 9.55	P15D8 = 15.80; P5D9 = 12.60; P6D6 = 12.94

Therefore, three outliers for the overall sample are identified, the same as the ones identified when treating male participants separately. If the female participants are treated separately, it can be observed that an extra participant (P9D7-female) is added to the list of outliers.

Correlation: Average speed – Age

X Values *(Age)*
∑ = 4740
Mean = 71.818
∑ (X - Mx)2 = SSx = 7787.818

Y Values *(Average speed)*
∑ = 930.321
Mean = 14.096
∑ (Y - My)2 = SSy = 2972.178

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = -671.497

R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = -0.1396
Meta Numeric (cross-check)
r = -0.1396

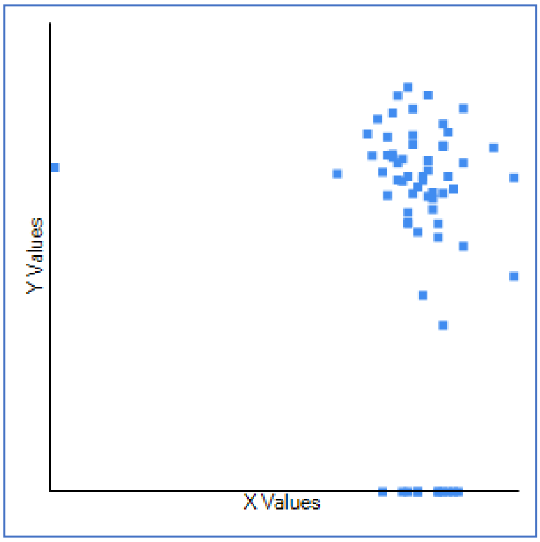


Figure 12 - Average speed by age for emergency braking

Although technically a *negative correlation*, the relationship between the variables is only *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .265674. The result is **not significant** at p < .05.

Correlation: Average speed – Weekly driving distance

X Values *(Weekly driving distance: Up to 20 miles = 1; 20 to 50 miles = 2; 50 to 100 miles = 3; 100 to 250 miles = 4; Over 250 miles = 5)*
∑ = 168
Mean = 2.545
∑ (X - Mx)2 = SSx = 92.364

Y Values *(Average speed)*
∑ = 930.321
Mean = 14.096
∑ (Y - My)2 = SSy = 2972.178

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 125.561

R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.2396
Meta Numeric (cross-check)
r = 0.2396

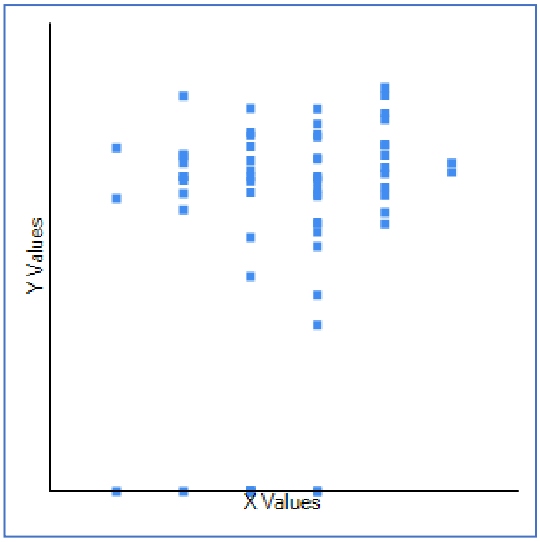


Figure 13 - Average speed by weekly driving distance for emergency braking

Although technically *a positive correlation*, the relationship between the variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .052665. The result is **significant** at p < .05.

Correlation: Average speed – Driving frequency

X Values *(Driving frequency: Monthly = 1; Weekly = 2; Twice a week = 3; Every other day = 4; Daily = 5)*
∑ = 258
Mean = 3.909
∑ (X - Mx)2 = SSx = 95.455

Y Values *(Average speed)*
∑ = 930.321
Mean = 14.096
∑ (Y - My)2 = SSy = 2972.178

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 69.178

R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.1299
Meta Numeric (cross-check)
r = 0.1299

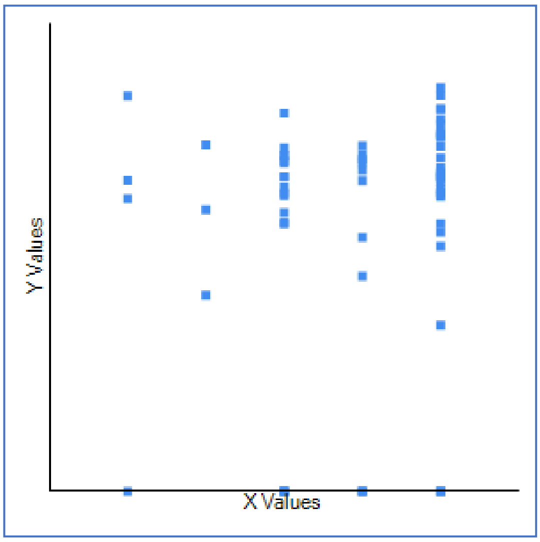


Figure 14 - Average speed by driving frequency for emergency braking

Although technically *a positive correlation*, the relationship between the variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .298544. The result is **not significant** at p < .05.

Hazard perception – daytime and night-time

Table 35 - Duration, speed and braking of hazard perception scenario

Hazard Perception Daytime and Night-time Gender	Number of participants	Average of HD total duration	Average of HN total duration	Average of HD total braking time	Average of HN total braking time
F	21	195.58	169.03	16.30	16.82
M	45	174.32	159.40	16.74	17.58
Grand Total	**66**	**179.64**	**161.99**	**16.63**	**17.37**

Correlation: Average duration daytime – Average duration night-time

***X Values** (Average HD total duration)*
∑ = 10059.57
Mean = 152.418
∑ (X - Mx)2 = SSx = 444588.01

***Y Values** (Average HN total duration)*
∑ = 8423.59
Mean = 127.63
∑ (Y - My)2 = SSy = 506343.021

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 247497.298
R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.5216
Meta Numeric (cross-check)
r = 0.5216

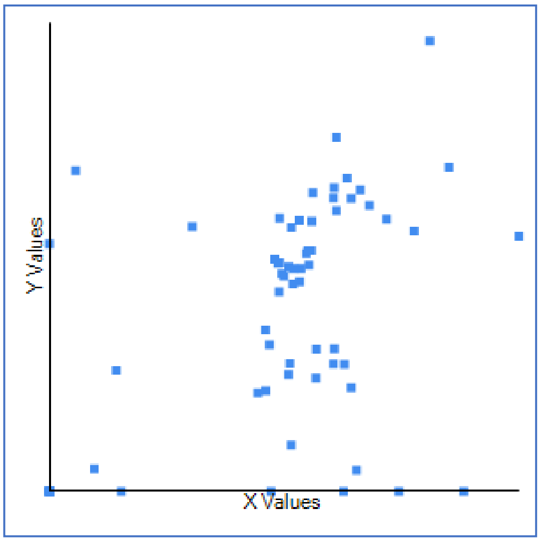


Figure 15 – Average duration of daytime scenario by average duration of night-time scenario

This is a *moderate positive correlation*, which means there is a tendency for high X variable scores go with high Y variable scores (and vice versa). The P-Value is <.00001. The result is **significant** at p < .05.

Correlation: Average braking time daytime – Average braking time night-time

***X Values** (Average HD braking time)*
∑ = 931.31
Mean = 14.111
∑ (X - Mx)2 = SSx = 12787.593

***Y Values** (Average HN braking time)*
∑ = 903.43
Mean = 13.688
∑ (Y - My)2 = SSy = 10422.527

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 5150.864
R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.4462
Meta Numeric (cross-check)
r = 0.4462

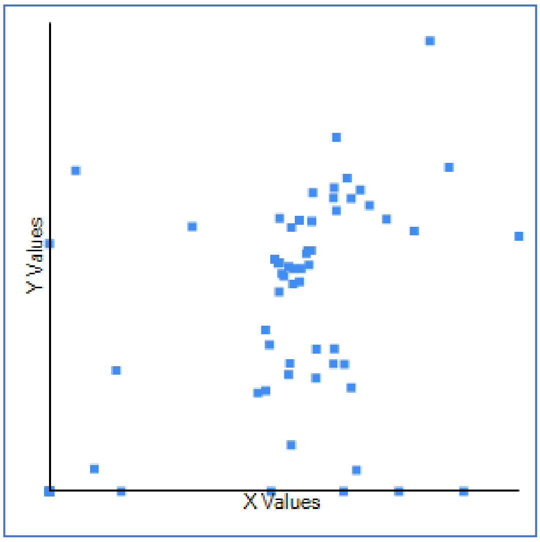


Figure 16 - Average braking in daytime scenario by average braking in night-time scenario

Although technically a *positive correlation*, the relationship between your variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is <.000173. The result is **significant** at p < .05.

Table 36 - Average speed and maximum speed in daytime and night-time hazard perception scenarios

Hazard Perception Daytime and Night-time Gender	Number of participants	Average of HD average speed	Average of HN average speed	Average of HD max speed	Average of HN max speed
F	21	10.65	9.58	26.16	24.57
M	45	11.34	10.67	26.31	24.28
Grand Total	**66**	**11.17**	**10.38**	**26.27**	**24.36**

Correlation: Average speed daytime – Average speed night-time

X Values *(Average HN speed)*
∑ = 539.69
Mean = 8.177
∑ (X - Mx)2 = SSx = 1457.202

Y Values *(Average HD speed)*
∑ = 625.37
Mean = 9.475
∑ (Y - My)2 = SSy = 1287.711

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 982.694
R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.7174
Meta Numeric (cross-check)
r = 0.57174
This is a *moderate positive correlation*, which means there is a tendency for high X variable scores go with high Y variable scores (and vice versa). The P-Value is <.00001. The result is **significant** at p < .05.

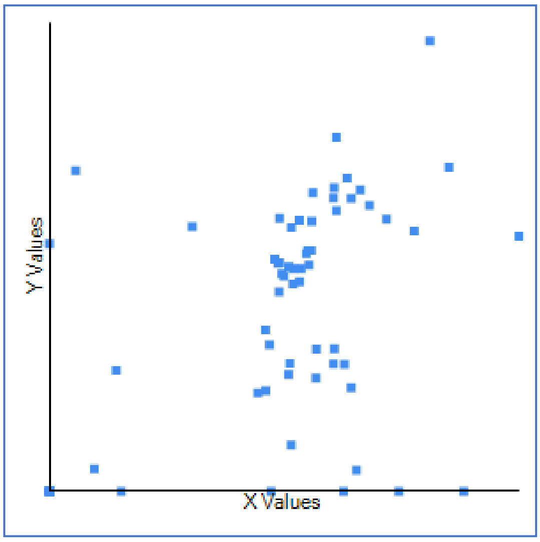


Figure 17 - Average speed in daytime scenario by average speed in night-time scenario

Correlation: Average speed time daytime – Age

X Values *(Average Age)*
∑ = 4740
Mean = 71.818
∑ (X - Mx)2 = SSx = 7787.818

Y Values *(Average HD speed)*
∑ = 625.37
Mean = 9.475
∑ (Y - My)2 = SSy = 1287.711

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = -571.836
R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = -0.1806
Meta Numeric (cross-check)

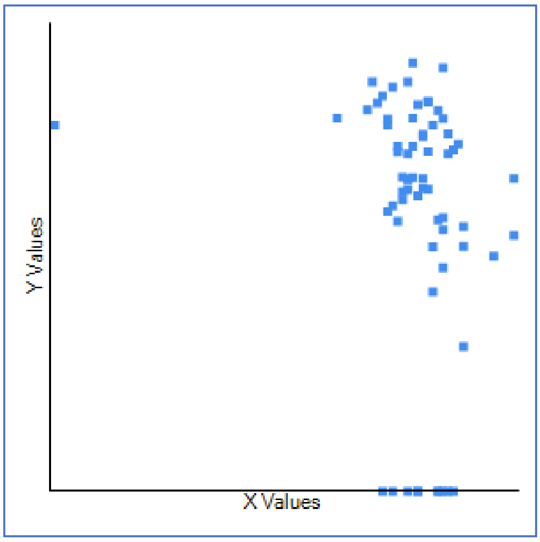


Figure 18 - Average speed in daytime scenario by age

r = -0.1806
Although technically a *negative correlation*, the relationship between your variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .148113. The result is **not significant** at p < .05.

Correlation: Average speed time daytime – Weekly driving distance

X Values *(Weekly driving distance: Up to 20 miles = 1; 20 to 50 miles = 2; 50 to 100 miles = 3; 100 to 250 miles = 4; Over 250 miles = 5)*
∑ = 168
Mean = 2.545
∑ (X - Mx)2 = SSx = 92.364

Y Values *(Average HD speed)*
∑ = 625.37
Mean = 9.475
∑ (Y - My)2 = SSy = 1287.711

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 120.429
R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.3492
Meta Numeric (cross-check)
r = 0.3492

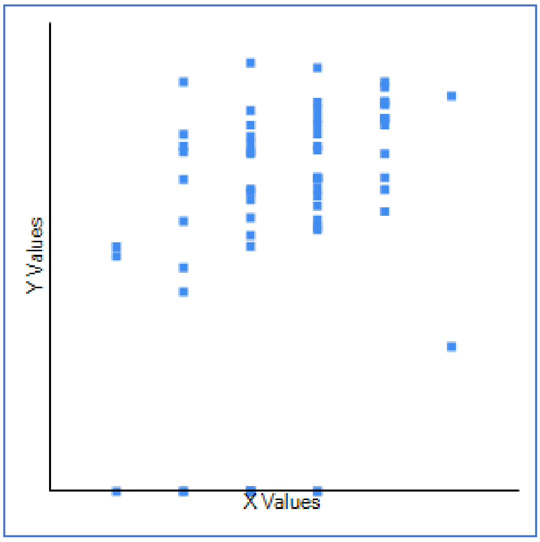


Figure 19 - Average speed in daytime scenario by weekly driving distance

Although technically a *positive correlation*, the relationship between your variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is .004056. The result is **significant** at p < .05.

Correlation: Average speed time daytime – Driving frequency

X Values *(Driving frequency: Monthly = 1; Weekly = 2; Twice a week = 3; Every other day = 4; Daily = 5)*
∑ = 258
Mean = 3.909
∑ (X - Mx)2 = SSx = 95.455

Y Values *(Average HD speed)*
∑ = 625.37
Mean = 9.475
∑ (Y - My)2 = SSy = 80.012

X and Y Combined
N = 66
∑ (X - Mx) (Y - My) = 5150.864
R Calculation
r = ∑ ((X - My) (Y - Mx)) / √((SSx)(SSy)) = 0.2282
Meta Numeric (cross-check)
r = 0.2282

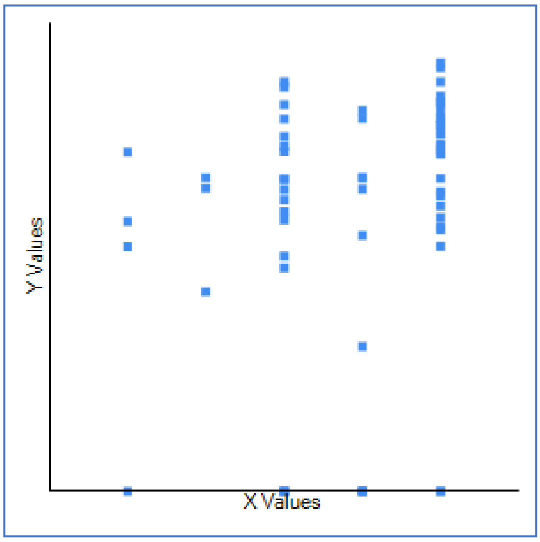


Figure 20 - Average speed in daytime scenario by driving frequency

Although technically a *positive correlation*, the relationship between your variables is *weak* (the nearer the value is to zero, the weaker the relationship). The P-Value is <.065346. The result is **not significant** at p < .05.

Identifying outliers

Table 37 - Identifying outliers in the daytime hazard perception scenario data

Hazard perception daytime				
	Total duration	Total braking time	Average speed	Maximum speed
Mean	179.63518	16.63054	11.16732	26.27125
Standard Deviation (s)	55.72533	13.77804	2.04305	4.94563
Lowest Score	18.32	0.7	4.95	16.07
Highest Score	327.02	86.22	14.63	35.17
Distribution Range	308.7	85.52	9.68	19.1
Total Number of Scores	56	56	56	56
Number of Distinct Scores	56	56	52	54
Low 95% interval	68.18	0	7.08	16.58
High 95% interval	291.09	44.19	15.25	36.16
Outliers	P10D4 = 31.24; P1D4 = 18.32; P2D4 = 50.12; P5D9 = 46.47; P5D5 = 327.02	P11D8 = 48.58; P14D8 = 86.22	P2D4 = 4.95; P5D9 = 6.82	P11D4 = 16.41; P5D9 = 16.55

Table 38 - Identifying outliers in the night-time hazard perception scenario data

Hazard perception night-time				
	Total duration	Total braking time	Average speed	Maximum speed
Mean	161.99212	17.37365	10.37865	24.36212
Standard Deviation (s)	65.21336	11.79323	2.29687	6.25881
Lowest Score	15.86	0	2.89	4.67
Highest Score	336.46	58.12	17.58	39.23
Distribution Range	320.6	58.12	14.69	34.56
Total Number of Scores	52	52	52	52
Number of Distinct Scores	52	49	47	52
Low 95% interval	31.57	0	5.78	11.84
High 95% interval	292.42	40.96	14.97	36.88
Outliers	P10D4 = 16.96; P6D8 = 15.86	P14D8 = 58.12; P3D7 = 43.68	P8D5 = 17.58	P6D8 = 4.67; P2D7 = 39.23

Junction analysis

Table 39 - Duration, average speed and indicating time for daytime and night-time junction scenarios

Junction	Average of HD junction duration	Average of HN junction duration	Average of HD junction average speed	Average of HN junction average speed	Average of HD junction indicating time	Average of HN junction indicating time
Junction 1	1.38	1.39	8.90	7.93	1.11	1.07
Junction 2	2.81	2.80	5.67	3.70	2.21	2.08

Table 40 – Average hazard duration for daytime hazards

Average hazard duration Daytime Gender	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
F	1.83	3.56	4.97	2.06	1.34	0.96	0.86
M	1.57	3.06	3.69	2.62	1.29	0.91	1.06
Grand Total	**1.63**	**3.18**	**4.01**	**2.48**	**1.30**	**0.92**	**1.01**

Table 41 - Daytime hazard perception outliers

Hazard perception daytime – hazard duration							
	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
Mean	1.63518	3.18304	4.00929	2.47911	1.3025	0.92143	1.00679
Standard Deviation (s)	0.41548	1.00402	2.7922	1.67377	0.9414	0.33643	0.82715
Lowest Score	1	0	0	0	0	0	0
Highest Score	2.59	5.01	11.97	6.98	5.92	1.81	5.72
Distribution Range	1.59	5.01	11.97	6.98	5.92	1.81	5.72
Total Number of Scores	56	56	56	56	56	56	56
Number of Distinct Scores	46	47	52	49	41	33	34
Low 95% interval	0.80	1.18	0	0	0	0.25	0
High 95% interval	2.47	5.19	9.59	5.82	3.19	1.59	2.66
Outliers	P11D4 = 2.47; P14D8 = 2.59; P8D4 = 2.53	P10D4 = 0.00; P1D4 = 0.00; P2D4 = 0.00	P10D4 = 0.00; P11D7 = 0.00; P11D8 = 10.92; P14D8 = 11.97; P1D4 = 0.00; P2D4 = 0.00; P5D9 = 0.00	P10D4 = 0.00; P11D7 = 0.00; P15D8 = 6.57; P1D4 = 0.00; P2D4 = 0.00; P3D9 = 6.98; P5D9 = 0.00; P6D4 = 6.14	P10D4 = 0.00; P11D7 = 0.00; P11D8 = 5.92; P1D4 = 0.00; P2D4 = 0.00; P5D5 = 4.70; P5D9 = 0.00; P9D7 = 3.26	P10D4 = 0.00; P11D4 = 1.81; P11D7 = 0.00; P1D4 = 0.00; P2D4 = 0.00; P5D9 = 0.00	P10D4 = 0.00; P11D7 = 0.00; P14D8 = 5.72; P15D8 = 3.15; P1D4 = 0.00; P2D4 = 0.00; P5D9 = 0.00

Table 42 - Average hazard duration for night-time hazards

Average hazard duration Night-time Gender	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
F	1.78	3.52	6.12	1.88	0.82	0.74	0.74
M	1.67	3.67	4.86	1.80	0.84	0.83	0.71
Grand Total	**1.70**	**3.63**	**5.20**	**1.82**	**0.83**	**0.80**	**0.72**

Table 43 – Night-time hazard perception outliers – hazard duration

Hazard perception Night-time – hazard duration							
	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
Mean	1.69942	3.62808	5.20308	1.81962	1.17054	1.12595	1.00541
Standard Deviation (s)	0.59805	1.27604	3.41921	1.37502	0.29925	0.5024	0.45156
Lowest Score	0	0	0	0	0.72	0.81	0.55
Highest Score	4.1	9.52	21.59	7.84	2.2	3.85	2.87
Distribution Range	4.1	9.52	21.59	7.84	1.48	3.04	2.32
Total Number of Scores	52	52	52	52	37	37	37
Number of Distinct Scores	43	45	47	43	35	31	29
Low 95% interval	0.50	1.08	0	0	0.57	0.12	0.10
High 95% interval	2.90	6.18	12.04	4.61	1.77	2.13	1.91
Outliers	P14D8 = 3.21; P1D9 = 4.10	P14D8 = 9.52	P8D8 = 21.59	P5D5 = 4.75; P6D6 = 5.24; P9D8 = 7.24	P6D4 = 2.20	P6D4 = 3.85	P8D4 = 2.50

Table 44 - Average speed at daytime hazards

Average hazard speed Daytime Gender	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
F	11.46	12.58	7.55	10.21	15.45	19.96	23.04
M	13.71	14.51	9.05	9.50	17.43	21.02	22.90
Grand Total	**13.15**	**14.00**	**8.67**	**9.68**	**16.93**	**20.75**	**22.93**

Table 45 - Outliers from hazard average speed - daytime

Hazard perception daytime – hazard average speed							
	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
Mean	13.14714	13.99981	8.66608	9.67863	16.92804	20.75078	22.93392
Standard Deviation (s)	3.29421	2.69302	3.114	3.83469	3.67469	2.70053	4.60455
Lowest Score	7.8	7.44	3.16	3.14	6.17	11.24	11.82
Highest Score	20.18	20.36	15.68	16.99	24.38	27.2	32.07
Distribution Range	12.38	12.92	12.52	13.85	18.21	15.96	20.25
Total Number of Scores	56	53	51	51	51	51	51
Number of Distinct Scores	54	52	50	50	50	50	50
Low 95% interval	6.56	8.61	2.44	2.01	9.58	15.35	13.72
High 95% interval	19.74	19.39	14.89	17.35	24.28	26.15	32.14
Outliers	P1D4 = 19.93; P1D6 = 20.18	P12D7 = 20.36; P15D8 = 7.44; P9D7 = 7.96	P1D8 = 15.68; P8D5 = 15.17	N/A	P11D4 = 9.13; P5D8 = 24.34; P6D7 = 24.38; P9D7 = 6.17	P11D4 = 11.24	P11D4 = 11.82

Table 46 - Average speed at night-time hazards

Average hazard speed Night-time Gender	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
F	11.70	13.07	6.96	13.69	18.35	20.53	24.92
M	12.86	13.35	7.68	13.23	18.48	20.09	23.44
Grand Total	**12.56**	**13.28**	**7.49**	**13.36**	**18.45**	**20.21**	**23.84**

Table 47 - Outliers from hazard average speed - night-time

Hazard perception night-time – hazard average speed							
	Van emerges from driveway	Man walks around truck	Car emerging from driveway	Truck turning into junction	Car pulling away from kerb	Oncoming motorbike at roundabout	Car turning right
Mean	12.56333	13.2804	7.49	13.35479	18.44595	20.21054	23.84162
Standard Deviation (s)	3.05822	2.38989	2.73033	4.70909	4.36071	3.14307	5.03398
Lowest Score	4.94	6.07	1.12	2.59	9.39	13.04	16.1
Highest Score	18.64	19.49	14.35	25.18	28.36	25.08	37.96
Distribution Range	13.7	13.42	13.23	22.59	18.97	12.04	21.86
Total Number of Scores	51	50	49	48	37	37	37
Number of Distinct Scores	49	50	48	47	37	37	36
Low 95% interval	6.45	8.50	2.03	3.94	9.72	13.92	13.73
High 95% interval	18.68	18.06	12.95	22.77	27.17	26.50	33.91
Outliers	P14D8 = 6.30; P1D9 = 4.94	P14D8 = 6.07	P1D8 = 13.18; P8D5 = 14.35; P8D8 = 1.12	P6D6 = 3.85; P9D8 = 2.59	P6D4 = 9.39; P8D5 = 28.36	P9D8 = 13.04	P2D7 = 37.96

Table 48 - Outlier participants

Participant	Outlined for	Count
P14D8	High - braking time HP daytime	9
	High - braking time HP night-time	
	High - duration H1 daytime	
	High - duration H3 daytime	
	High - duration H7 daytime	
	High - duration H1 night-time	
	High - duration H2 night-time	
	Low - speed H1 night-time	
	Low - speed H2 night-time	
P11D4	Low - speed emergency braking	7
	Low - max speed HP daytime	
	High - duration H1 daytime	
	High - duration H6 daytime	
	Low - speed H5 daytime	
	Low - speed H6 daytime	
	Low - speed H7 daytime	
P11D8	Low - speed emergency braking	4
	High - braking time HP daytime	
	High - duration H3 daytime	
	High - duration H5 daytime	
P15D8	Low - speed emergency braking	4
	High - braking time emergency braking	
	High - duration H4 daytime	
	Low - speed H2 daytime	
P8D5	High - speed HP night-time	4
	High - speed H3 daytime	
	High - speed H3 night-time	
	High - speed H5 night-time	
P6D4	High - duration H4 daytime	4
	High - duration H5 night-time	
	High - duration H6 night-time	
	Low - speed H5 night-time	
P5D9	High - braking time emergency braking	4
	Low - speed HP daytime	
	Low - max speed HP daytime	
	Low - duration HP daytime	
P9D8	High - duration H4 night-time	3
	Low - speed H4 night-time	
	Low - speed H6 night-time	
P9D7	High - duration H5 daytime	3
	Low - speed H2 daytime	
	Low - speed H5 daytime	
P6D6	High - braking time emergency braking	3
	High - duration H4 night-time	
	Low - speed H4 night-time	
P5D5	High - duration HP daytime	3
	High - duration H5 daytime	
	High - duration H4 night-time	

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