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Chapter 10: Technologies, Education and Training to Improve Older Driver Behaviour

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Running header: Technology, education and training for older drivers

Abstract

There are many cognitive training tests purported to both measure older people's cognitive performance, several of which come with associated training that it is deemed can improve that cognition. This chapter describes cognitive tests that have been claimed to be linked to driver behaviour, and that training on them could improve driver behaviour. Of special interest are tests that could be completed at home on a computer, as it is suggested this could capture many individuals who are worried about attending a driver assessment centre and are not likely to be referred. Findings suggest that three cognitive tests (Useful Field of View) and Dual N have research suggesting that training on them could improve driver performance for older drivers. However, the robustness of the research is debateable. There are also two physiological tests – a neck and shoulder and a general fitness test that also show promising results for improving driver performance. In addition, education and training is purported to improve driver behaviour, but although there is positive feedback from older people who attend and some short-term improvements, research on long-term improvements on driver behaviour are not yet evident. Overall, there are promising results from individual cognitive, physiological tests and from education and training suggesting that reflection on action and feedback from the task is important to improving driver performance but more research is needed.

Key words: driver behaviour, technology, ageing, cognition, training, driver assessment

1. Introduction

In terms of car driving, casualty rates per miles driven is at its lowest at 70 years of age and begins to increase from around 75 years (see chapter 3), some of this increase is almost certainly due to frailty as suggested by deaths and KSI rising faster than all casualties rather than being an increased danger on the road.

That said, older people from the age of 70 become more likely than not to be “at blame” for road accidents they are involved in, according to official police records (Clarke et al., 2009; Mitchell, 2013). Clarke et al. (2009) reviewed STATS19 data (police on-scene incident record in Great Britain) and found older drivers are over represented as a casualty at fault in collisions at junctions, in merging traffic, with turns across the road and in busy traffic. Van Elsande and Fleury (2000) estimated that 19% of older driver crashes are due to their cognitive abilities being overwhelmed and that if eyesight issues are added the figure rises to 40% (Staplin et al., 2003a,b). Langford et al. (2006) suggest that low mileage drivers entirely make-up the increase in numbers in this category post 75 years of age, maybe as a result of self-selection; safer drivers are driving a higher number of miles.

Charlton, et al. (2001) Cushman (1996) and Marottoli and Richardson (1998) suggest older people are not very good at judging their own ability; they may generically feel more vulnerable but this does not equate well to actual driver ability (Rabbitt et al., 1996). Nevertheless, older people do compensate for their (perceived) changes in ability, for example by driving slower, taking breaks, taking roads they feel comfortable with (e.g. not using motorways – largely due to the merging traffic, not taking difficult turns across traffic), driving when conditions suit them (not in low sun, not in heavy rain, avoiding the dark and the rush-hour are often cited) and even acquiring vehicles to suit their needs (tall vehicles, with much vision, stiff ride with noticeable feedback and buying vehicle with power steering, automatic gears) (Baldock et al., 2006; Holland, 2001; Musselwhite and Haddad, 2010; Musselwhite and Shergold, 2013; Rabbitt et al., 1996; Rabbitt and Parker, 2002).

Table 1 maps the driver errors older people have to cognitive and other changes associated with ageing (adapted from Musselwhite, 2017).

Driving issue pertinent to older drivers	Attention	Cognitive Overload	Cognitive processing speed	Perceptual speed	Workin g memory	Task switching
over represented in collisions at junctions, in merging traffic, with turns across the road and in busy traffic (Clarke et al., 2009) esp. judgements of relative speed, time gap judgements (Oxley et al., 2006; Preusser et al., 1998)	x	X	X	X	x	
Difficulties in navigating unfamiliar routes (Holland, 2001)	x	x				x
Maintaining speed and tracking (Brendemuhl, Schmidt and Schenk, 1988; Mussewhite and Haddad, 2008, 2010b; Schlag, 2003)	X			x		
Being distracted by radio, passengers, outside (Holland,	x	x			x	x

2001; Musselwhite and Haddad, 2008, 2010)						
Inability to see under poor lighting (glare, darkness, luminance) (Janke, 2004; Musselwhite and Haddad, 2008, 2010b)						
Reaction times (Musselwhite and Haddad, 2008, 2010)	x		x		x	x
Tiredness/fatigue (Musselwhite and Haddad, 2008, 2010b)						

Table 1: Typical older driver errors and changes in cognition, eyesight and other physiological issues that contribute to

2. General training programmes for older drivers

2.1 Training to improve cognition that can also improve driver behaviour

Brain training or brain fitness programmes have been developed to either improve cognition in later life or to make individual aware of their cognitive limitations. Brain training is "the engagement with a specific program or activity that aims to enhance cognitive skill or general cognitive ability as a result of repetition over a circumscribed timeframe" (Rabipour and Raz, 2012, page 159).Brain training is related to neuroplasticity, that the brain is malleable can change or even grow in relation to stimuli (Calero and Navarro, 2007). The following section includes brain training programmes that has been shown to be related to driver safety and that can be trained for.

2.1.1. The Useful Field of View (UFOV) Test and Training

The Useful Field of View (UFOV) test is a computer based measure of cognitive processing speed and attention. The test consists of 3 sub-tests:-

1. Processing Speed: Determines a person's threshold for discriminating stimuli presented in central vision. Participants are required to identify a silhouetted shape in a central fixation box.
2. Divided Attention: Builds on sub-test 1 by adding a peripheral target simultaneously.
3. Selective Attention: Requires central and peripheral target identification (as in sub-tasks 1 and 2) but with additional distractor shapes.

Poor results on UFOV relate to increased crash involvement and poorer driver performance (Ball and Owsley, 1992; Ball et al., 1991, 1993; Clay et al., 2005; Goode et al., 1998; Horswill et al., 2011; Mathias and Lucas, 2009; Staplin et al., 2003a,b). On specific driver ability tests there is still a relationship between poor UFOV performance and driver behaviour but relationship tends to be quite weak (Selander et al., 2011) and in populations with mild cognitive impairments, the relationship is non-existent (Bohensky et al., 2007).

Computer based training can improve results on UFOV which then translates to improving driver behaviour, for example, Ball et al. (2010) found ten 70 minute training sessions for older people led by an instructor over five weeks (two per week) reduced at-fault crashes by 51% over the following five years as compared to a control group. It can also contribute to faster reaction times and reduced risky driving manoeuvres (Roenker et al., 2003). Overall it has been shown to reduce premature driver cessation (Edwards et al., 2009) and in turn improve physical health, quality of life and reduce depressive symptoms in older adults (Wollinsky et al., 2006a,b, 2009). It seems the training must be directly related to UFOV to be of impact, for example use of generic computer games, including Medal of Honour (1st person shooting game) and Tetris (shape arranging game), for example, although increase engagement and “flow” have few UFOV improvements and have no relation to improvements in driver behaviour (as measured on a simulator) (Belchoir, 2007).

2.1.2. Trail making test

The Trail Making Test consists of two tests, Part A requires a participant to join up numbered shapes in sequence, usually from 1 to 25 as quickly as possible. This measures visual search capability. Part B requires the participant to join numbers and letter together in order 1-A-2-B-3-C and so on Part B measures working memory and task switching ability.

Emerson et al (2012) found poorer scores on part A or part B were related to the number of crashes an older driver had. Staplin et al. (2011) found part B is related to at fault crashes in their sample of 2,500 drivers in three samples drawn from license renewal, medical referral, and residential community populations. Training can be improved via cognifit techniques (see Cognifit section; Shatil et al., 2014).

2.1.3. Motor-Free Visual Perception Test, Visual Closure sub-test

The Visual Closure subtest of the Motor-Free Visual Perception Test (MVPT/VC) is a multiple-choice test that measures a person's ability to visualize incomplete figures when only fragments are presented (Colarusso and Hammil, 1996). This ability is important to the driving task, insofar as drivers must recognize a sign or other traffic control device that is only partly visible, or quickly perceive the safety threat represented by a vehicle or pedestrian that is partially obstructed (e.g., by a building or parked car) at the side of the road, and may be about to move into the driver’s path. The Motor-Free Visual Perception Test/Visual Closure subtest was most predictive of (at-fault) crash involvement by drivers in the License Renewal sample of 2500 older drivers, by a wide margin (Staplin et al., 2003a,b).

2.1.4. Delayed Recall Test

The Delayed Recall test, from the Mini-Mental Status Examination (Folstein, Folstein, and McHugh, 1975), is related to working memory. Working memory is important to safe driving because it allows a driver to recognise and remember signs, rules, navigation and moment to moment hazard detection and vehicle control (Staplin et al., 2003a,b). Performance on the test requires participants to recall three words, once achieved delayed recall condition is added by allowing a certain amount of minutes (often 10 minutes in the first instance) to pass before repetition is required (participants are told they should remember them for recall). Performance on the delayed recall test is related to at fault driver crashes (Staplin et al., 2003a,b). Delayed recall test can be improved with training, both specific memory training and more generic cognitive engagement with a task (see Kueider et al., 2012 for review), but whether such training is then related to reducing crashes at the wheel is yet to be tested.

2.1.5. Computerized Maze Navigation

Participants complete trace a path through a computerised maze. A study by Ott et al. (2003, 2008) found analysing participants (n=133) completing a series of five mazes, calculating errors, planning time, drawing time and total time could distinguish older people's driving performance on a test track both for those with Alzheimer's disease and those with no cognitive impairment. The total test time was highly correlated with Trail Making A test and the Hopkins Verbal Learning Tests Trial 1 in both sets of participants. With a larger sample (n=692) of older people aged 70-93, Staplin et al (2003a,b) found maze test results are linked with crash involvement.

2.1.6. Speed of processing training

Simple and choice reaction time was trained in a driver simulator with a group of older people with decreased cognitive function (Roenker, Cissell, Ball, Wadley, and Edwards, 2003). Simple reaction time was trained by making participants brake as fast as possible in relation to brake lights. Choice reaction time was trained by getting participants to react to different traffic signs which told the person to brake, turn the wheel or do nothing. The trained group had improved reaction time compared to the control group (no training), and improved on an on-road evaluation of their driving especially on turning and signal use. These improvements were not noted at an 18 month follow-up, however.

2.1.7. Dual n-back task for working memory

The dual n-back task is related to working memory. In the ordinary n-back task, the participant is presented with a series of stimuli, for example words or letters and must indicate when the current stimulus matches one from n steps earlier in the sequence. The n is changed and made more difficult if the participant is performing well, so the task is incremental. In the dual-task version, two independent sequences are presented at the same time usually one presented verbally and one visually. Participants were given training for the test 5 days a week (lasting around 20-25 minutes) for five weeks, totalling 25 sessions, compared to a control that received training on trivia. Those who received training improved other elements of working memory and this did transfer to driving performance, albeit measured on a driver simulator (Seidler et al., 2010)

2.1.8. Hazard perception tests

Horswill et al. (2010) found a relationship between the time taken to identify hazards on a standard hazard perception test and crash involvement among a sample of 271 older drivers.

2.2. Physical aids

There is a long tradition of using physical tests to screen for problems in driver behaviour. There is less evidence that training may improve older people's driver behaviour, but they can raise awareness of barriers to good driver behaviour. Among the physical measures, the Rapid Pace Walk, Head/Neck Rotation and general fitness appear to have the greatest potential value as predictors of driving impairment.

2.2.1. Rapid Pace Walk

Motor speed, balance, and coordination can be assessed with the rapid-pace walk test. The participant must walk 3 metres, turn around, and walk back to the starting point as quickly as possible. Normal aids to walking can be used, such as a cane or a walking-stick. Linking results on the test to adverse driving events (traffic accident, violation, stopped by police), 9% of those who walked faster than 7 seconds had had an adverse driving event compared to 17% of those walking at or slower than 7 seconds (Marottoli, Cooney, Wagner, Doucette, and Tinetti, 1994).

2.2.2. Shoulder, neck and head rotation

Hunter-Zaworski (1990) found older people with impaired neck flexibility took longer to react to hazards presented on a simulator than those with no impairment. Interestingly impaired neck flexibility in younger participants made no significant difference. Ostrow, Shaffron, & McPherson, (1992) found an 8 week stretching and exercise program for those aged 60-85 that could be performed at home increased shoulder and trunk flexibility. Those without the exercise programme actually saw a decrease in such flexibility. In terms of driving, those on the exercise course significantly better than controls on "observing" (checking mirror, turning to check blind spots) and "vehicle handling" (parallel parking).

2.2.3. General fitness programmes

A graduated exercise programme for older people was developed to target stamina, flexibility, coordination, and speed of movement and was delivered weekly over 3 months by an occupational therapist visiting participants at their home. Results showed this could improve driver performance (as tested on an on-road test) compared to a control group who hadn't received such training whose performance had declined (Marottoli et al., 2007).

2.3. Combined cognitive training programmes

Some programmes bring together a variety of cognitive (and other) style screening tests and training, sometimes as games and in some cases bespoke to the needs of the individual, with some evidence that they improve driver behaviour for older people.

2.3.1. Cognifit and DriveFit

General cognitive training developed under names of Lumosity, CogMed and Cognifit. Cognifit has been used in driver training across all ages and had spawned DriveFit bespoke to driver behaviour. The CogMed games and exercises all focus on expanding various aspects of working memory. They include games such as Twist, Hidden, Pop-Up, 3d Grid, Correct, Sort, Numbers, Chaos, Rotating, Letters, Assembly and Cube. Cognifit involves 21 different screening and training games.

The CogMed software guides you through 12 rotating exercises each day. The exercises automatically adjust in difficulty according to participant's ability and results, thereby expanding your working memory capacity. Training requires five days per week over a period of five or six weeks (with a total of around 25 sessions) at about 30 minutes per day/session. One product repeatedly demonstrated to improve working memory (WM) capacity in both children and adults is Cogmed, which entails training on WM tasks for 5 days per week over a period of 5–6 weeks. Using this software, children with ADHD as well as healthy adults appear to improve in measures of WM as a result of training (Klingberg et al., 2005). The findings were later replicated in healthy adults (Olesen, Westerberg, & Klingberg, 2004; Westerberg & Klingberg, 2007), although both studies were unclear about the possibility of improvements due to test–retest effects.

Training on Cognifit can improve scores on TrailMaking part A and B, for example training on 3 (selected bespoke to the person's background needs) of the 21 different CogniFit training games over 8 weeks, three times a week for 20 minutes each, conducted via a television set at home and in groups, can improve scores (Shatil et al., 2014)

2.4. Self-assessment aids

These are workbooks people complete in their own time and often at their own pace. They are usually completed alone and hence are confidential and non-threatening (Eby et al., 2003; Heikkinen et al., 2010). They can act to stimulate discussion among family members (Eby et al., 2003). However, they are more likely to be completed by those who are safety conscious and motivated (Dunn, 2012).

2.4.1. Driving Decisions Workbook

The Driving Decisions Workbook was developed in America as a self-assessment tool for older drivers (Eby et al., 2000; Eby et al., 2003). It includes 37 evidence-based assessment areas linked to three domains. Each assessment area has a question for the driver to answer. A response is provided should the person answer with a negative. Responses include the following styles:

- general knowledge (e.g. prevalence, effects on driving),
- self-awareness (e.g. the likelihood that the user has the problem),
- recommendations for further assessment (e.g. driving evaluation, vision screening),
- suggestions for driving compensation (e.g. avoiding night driving).

Testing of the workbook has been favourable, the workbook corresponds with on-road driving test for those aged 65-74 (but not those aged 75+) and several cognitive battery tests. It is suggested that it can help driver's reflect on their own ability, making them more aware of changes and potentially help them make intentions to change behaviour as appropriate (Eby and Molnar, 2003).

2.4.2. Devon Driving Decisions Workbook

The tool was adapted for use in the UK by Devon County Council. It is a slightly shorter version that subsumes vision questions into one, as it does also with medication and drug questions. Evaluation (Dunn and Hellier, 2011) shows positive user acceptance but low engagement with the tool beyond two-four months. This resulted in older people not engaging in actions suggested by the tool to improve their safety in this longer time period. Participants felt it had corrected their driving and made them more aware of their own driving, but very few felt they required much further engagement beyond the initial period. Hence it was seen as corrective, rather than part of on-going training.

2.4.3. The Self-Awareness and Feedback for Responsible Driving (SAFER Driving) tool

The Driver Decisions Workbook was enhanced and re-written as a web-based self-assessment tool and focusses entirely on health related issues and driver behaviour. Health concerns centre on visual problems, attention deficits, slowed information processing, memory and orientation problems, depression and anxiety, pain, fatigue and motor problems. This is related to driver issues including planning and orientation, accelerating, decelerating and maintaining speed, manoeuvring, observing and responding and communicating intentions. Like the Driver Decisions Workbook, questions are asked and bespoke feedback given based on the responses and involve giving general or self-awareness, recommendations, suggest further evaluations or vehicle modifications. Evaluation is positive and there is evidence that it correlate with onroad driver performance (Molnar et al., 2010).

2.4.4. The Roadwise Review

The Roadwise Review (Staplin and Sinhr-Zarr, 2006) is a computer-based self-screening instrument for older drivers that contains several tests for the user to complete at home. Some of the tests require help from an additional person to administer but most can be done alone. The tests assess the following abilities: leg strength (rapid-pace walk test), head and neck flexibility (view object on screen behind them by turning neck and trunk, holding onto seat beneath them), high- and low-contrast visual acuity (differentiate different sized characters on a screen under high or low contrast), working memory (delayed recall test), visualization of missing information (subtest UFOV), divided visual search (Trail making test A&B), and visual information processing speed (subtest UFOV). The programme assesses problem areas and ways to correct them. Although it is favourably received by older drivers (Myers et al., 2008), evaluation shows no correlation with on-road tests, UFOV or trail making tests (Bédard, Riendeau, Weaver, and Porter, 2009), some of which is down to problems in the user interface of using the computer for such tests compared to pen and paper or instructor-led (see Porter, 2010). It can be downloaded for free at https://www.aaafoundation.org/roadwise-review-online

2.5. Education and training

Eby et al., (2009) and Molnar et al., (2007) reviewed education and training programmes for older people across the US. Many improve driver knowledge (see e.g., Eby et al., 2003; Marottoli, 2007; Owsley et al. 2004), improve self-reported driving behaviors (McCoy et al., 1993; Owsley et al., 2004) and improve on-road driving scores (Bédard et al., 2004; Marottoli, 2007), but there is no evidence to suggest they reduce crashes or injuries (Berube et al., 1995; Korner-Bitensky, Kua, von Zweck, & van Benthem, 2009; Ker et al., 2005; Kua et al., 2007; Nasvadi & Vavrik, 2007; Owsley et al., 2004). As St Louis et al (2011) note however, most of these programs have not been formally evaluated and further research is needed.

In the UK, the DRIVE 55 Plus refresher course from Dorset County Council aims to increase driver skills and knowledge, reduce risk of being in a collision and help deal with general driving conditions. It has two parts, a 3 hour refresher course involving a presentation and discussion by a driving instructor concentrating on driving laws, Highway Code, driving techniques, road layouts and fitness to drive and a practical refresher course with a driving instructor on a local route lasting 90 minutes. Evaluation shows older people enjoy the course and state they found it useful, but no attempt has been made to evaluate the course in terms of improvements in safety. Nasvadi (2007) examined the impact of attending a similar course, the Arrive Alive/Mature Driving education program which is an hour long video with discussion run by a qualified driving instructor. The video encourages road safety by highlighting awareness of rising traffic volumes, complex road systems, licencing requirements, eyesight requirements, effects of medication, changes to law and Highway Code. The presentation also provides tips and reminders about general good driving practice. A telephone survey of 367 drivers aged 55-94 one year after attendance on the course found 75% self-reported improved driving behaviour, most notably increased awareness of visual skills, better speed awareness and improved allowance of space to vehicles in front and improved manoeuvring skills. Nasvadi and Vavrik (2007) found evidence that older-old drivers (aged over 75) actually saw an increase in collisions for those attending the Arrive Alive/Mature Driving education programme compared to a control group of non-attendees, possibly showing the problem of over confidence.

Dorset Driver is a two-part theory and practical driver refresher programme aimed at older drivers developed by Dorset County Council. It is a two-part training programme delivered by Approved Driving Instructors (ADI's). The theory session lasts 2 hours and includes discussion on the effects of the ageing process on driving ability, tips on staying fit to drive, changes in the Highway Code, driving awareness on motorways and dual carriageways, avoiding stressful driving situations and practical advice on driving procedures and road positioning such as at roundabouts, on bends and at complex junctions. The workshop is an interactive session and includes hazard perception video footage taken in-car on local roads familiar to the older drivers. The practical session, referred to as a coaching session, takes place a few weeks or months after the practical session and is optional. It lasts 90 minutes and is assessed by ADIs who mark the driver on 30 different elements to identify strengths, weaknesses and suggest areas of improvements. Evaluation using a second practical onroad drive was undertaken by Hawley (2015) with 38 volunteers 6 months after they had taken part in both original sessions and was relatively positive; after the first practical session 92% (n=38) self-reported an increase in confidence negotiating roundabouts and an improved knowledge of road signs. 96% said they had learnt something new from their participation in the programme. Between the first and second practical onroad assessments, 76% of the drivers who took part showed an improvement (fewer errors), 11% had more errors than the first drive and 13% saw no change. In particular, improvements were noted in speed and hazard awareness, general vehicle control and overall road positioning. In terms of road positioning at both roundabouts and bends and judging safety margins, older people had noted these as being beneficial but actual changes in an onroad test in these areas was not seen. Research has not looked at impact of the course on crashes and collisions.

Based on interviews with older people giving-up driving, Musselwhite (2010) suggests that driver training should be accompanied by training that discusses life beyond the car, focussing on both emotional and practical support, aiding planning, which is known to help successful driver cessation (Musselwhite & Shergold, 2013). Liddle et al. (2007) has developed and evaluated such a course in Australia centred around seven modules delivered through in groups (Growing Older, Driving Later in Life, Adjusting to Losses and Changes, Experiences of Retiring from Driving, Alternative Transport, Lifestyle Planning, and Advocacy and Support); with the order and time allocated to each module determined by the needs and preferences of the group (Liddle et al., 2007). Evaluation suggests participation in the course also significantly predicted higher use of public transport and walking at immediately post-intervention; and increased aspects of community mobility self-efficacy, and higher satisfaction with transport at 3-month follow-up. However, this study was limited by a high attrition rate (and resulting small sample size), and a convenience sample of volunteers; and so further research is required to clarify the long-term impact of the course (Liddle, et al., 2013).

3. **Discussion**

Performance by older people on the Useful Field of View (UFOV), Trail Making Test part A and B (TMT/A, TMT/B), Motor-Free Visual Perception Test, Visual Closure Subtest (MVP T/VC), Delayed Recall, Maze test and Dual N task have all been shown to be related to number of crashes. Of these only UFOV and Maze test have been examined are related to driver behaviour. Speed of processing and the three physical tests are also related to driver performance. Training has been shown to improve performance on the UFOV, TMT A/B, Delayed Recall, Speed of Processing, Dual N and two physical tests (general fitness and specific neck and shoulder) training. Although it might be assumed improved training would also improve driver behaviour or reduce driver crashes in those tests, research has not always been carried out that demonstrates this. Hence, we can only surmise that it is highly likely such training will have an effect on driver performance. We can only tentatively conclude that UFOV, Dual N, neck and shoulder and general fitness training translates into improved driver behaviour. UFOV has had the most attention in this area, having been shown to correlate to many different domains of driver behaviour in older adults including crash involvement, driver performance, driver cessation (and associated mental health and wellbeing domains) (see section 2.1.1). But it has had most research carried out in this area; other tests may still improve driver behaviour in similar ways but more research is needed.

Mapping the training to known older driver issues shows that the UFOV again covers many particular problems, for example those involving attention, cognitive overload, cognitive processing speed and perceptual speed (see table 2). In combination with TMT A and B which covers working memory, task switching and visual search, the main cognitive issues related to older drivers are covered. Physical tests of shoulder and neck and general fitness can help improve other known issues. These four tests have been shown to be related to driver crashes and/or driver behaviour and can be trained for. Although more work is needed on how best to combine such training and how to present such training in a driver context, it is suggested these are the most appropriate tests and training to be considering when wanting to improve driver training for older people.

Education and driver training programmes targeted directly at improving driver behaviour sometimes involve some of the cognitive and physical tests mentioned above coupled with scenario discussions and on-road evaluations and training. Overall, these programmes are evaluated well, older people enjoy training and having a chance to learn something new and they enjoy the opportunity to reflect on their skills and abilities and focus in on limitations. Some studies suggest driver behaviour can improve but links to fewer accidents have not yet been studied on the whole. The only study to include this as a measure has found an increase in collisions, perhaps being linked to creating over confidence in the older driver (Nasvadi and Vavrik, 2007). Improvements in driver behaviour where noted tend also to be fairly short-lived.

Suites of cognitive (and physical) tests are found in Cognifit, CogMed and DriveFit as well as appearing within the education and training programmes. Yet, bringing together the most appropriate tests in the best manner has not really had much attention, especially in relation to driving based outcomes. How does training on one type of intervention affect learning from others, for example? What are the best combinations of training available and why? More research is certainly needed.

	UFOV	TMT A	TMT B	MVPT VC	Delayed Recall	Maze	Speed of processing	Dual N
Attention	x					Xx		
Cognitive Overload	x					X		x
Cognitive processing speed	x						x	
Perceptual speed	x							
Working memory			x	x	x			x
Task switching			x					
Visual search		x		x		X		
Neck								
Muscles								

Optical lobe	x					X		
Related to crashes	x	x	x	x	x	X		x
Related to driver behaviour	x					X	x	
Can be trained for	x	x	x		X		x	x
Training shown to improve driving	x						x (up to 18months after)	x

Table 2: Overview of cognitive and physical tests and training and relationship of these to cognitive and physiological (adapted from Musselwhite, 2017).

Packaging this training as an attractive, coherent and joined together programme is more problematic. People who engage in training are often at either end of the spectrum, they are motivated, conscientious people who want to improve their driving, often those who are already very self-aware, very careful and overall very good drivers, or they are those who have been referred to training due to an identified problem, either health or an identified issue on the road (they been involved in a crash or been spotted driving dangerously or poorly by the police, for example). There will inevitably be a large gap of people in the middle of these extremes who would clearly benefit from training. Some of these will believe they are already good enough, some will believe that training is of little help, some will be anxious about being told to give-up should they attend training, some maybe anxious about being evaluated, especially in front of others. How to motivate this group to interact with training has not yet been investigated. Self-completion training can help those who do not want to be assessed and evaluated in a public setting. These have been evaluated to be shown to help older people become more self-aware of their own driving imitations and help them formulate intentions to change. There is evidence from the SAFER driving tool, for example, that completion of the self-awareness programme can improve driver performance (Molnar et al., 2010) but there is no evidence it makes any changes to crashes or how long such changes lock in – Dunn and Hellier (2011) suggest that there is little engagement with such tools beyond an initial selection. Hence, any self-completion training programme needs a mechanism to keep people engaged for a longer time period. Indeed this is an issue across all training interventions. Training is often a one-off event, perhaps a system involving continuous feedback and monitoring would be more appropriate and more synonymous with everyday driving. At least training could be provided at regular intervals to maintain standards. Research to date has not really addressed the right levels of interval of presenting an intervention in order to make the appropriate improvements to driver behaviour or reduce crashes. More research is therefore needed on the long-term effect on driving behaviour from a one-off intervention.

Elements that have not been looked at in conjunction with training and interventions for older people include psychosocial responses to driving, including emotive reactions, attitudes and perceptions. Given the emotive nature of giving-up driving, this seems somewhat of an omission. Attitudes have been recognised as an important component of driver training for novice drivers (see Musselwhite et al, 2010) but have largely been disregarded for older drivers.

Overall there is always the need for careful evaluation of a proposed intervention. Most worryingly with this type of training is the potential for over confidence that may lead to more risky behaviour and consequently more crashes. Alternatively the opposite may happen, people may lose confidence unnecessarily. The need for balancing this with appropriate feedback based on robust evaluation is crucial.

4. **Recommendations**

The following recommendations are made with regards to developing training programmes as interventions for improving driver behaviour and/or reducing older people's crashes on the road:

4.1. The package should be attractive

It must give older people a need or a desire to want to complete or interact with it, perhaps with some intrinsic or extrinsic reward. For example, extrinsically the package could involve rewards, for example cheaper insurance premiums or more simply a certificate of completion. Intrinsically the package must be fun to use and engage with, perhaps examining how the training could be turned into a game. Utilising education and gaming theory, engagement is maintained throughout programmes by increasing challenges in line with rewards and completion, moving up levels with increasing complexity, for example.

4.2. The training should work within norms and expectations.

The package should be developed with knowledge of older people's norms and expectations, without being patronising. The design needs to be for older people, but without necessarily and explicitly looking like a traditional old person's intervention. The design needs to make the package accessible to fit in with everyday lives and driving experiences of older people, while also revealing new insights. Too much novelty and the package will be discredited.

4.3. Training should be based on real-time, realistic needs of older people. Some of the programmes above that have been successful have tailored the training or intervention to specific needs of older people (e.g Cognifit, Drivefit). This should be maximised where possible and could be done through screening tests of knowledge or skills, self-reported data on driver behaviour or health details. More cleverly this could be done through collection of real-time driver data utilising data collection methods such as black box technology and using algorithms to compare driver signatures collected from actual driving (see Ellison et al., 2015). This could then be used (against a benchmark) to identify issues and problems that could then lead to certain training packages/games being completed. Hence, packages to aid driver improvement could be made in-line with data collected.

4.4. Training must involve quality feedback.

People need to know how well they are doing, compared to any benchmarks set. Benchmarks are often set by experts (in conjunction with evidence based reviews), for example Advanced Driving Instructors. However, benchmarks could be set within-person data, to identify how far a person improves over time. They could also be normed against the population to highlight how well they are driving relative to others. In any case they need to be presented well and in an easy to understand manner.

4.5. Training must consider opportunities for social engagement.

Training that has reported to be successful is usually interactive (see also Henderson, 2003; Molnar et al., 2003) and often involves some form of social element. For example, in training and education sessions, discussions with others have been useful in getting individuals to reflect on their behaviour. Behaviour change can also be enhanced through social comparison and facilitation, so comparing progress on training interventions with those identified as similar to themselves can help with maximising the success of the intervention. This need not be in person but could be virtual connections if the training was done remotely on computers, for example.

4.6. Content of the training

A suite of training programmes should be available and tailored to the older person's needs. The suite should include cognitive tests of UFOV along with TMT A and B as well as encouraging neck and shoulder exercises and possibly general fitness. It should be investigated how far these might be developed as interactive games and within a driving format. Could UFOV and TMT A and B, for example, be converted into a game with incremental changes and levels to complete? Could UFOV or TMT A and B, for example, be developed as a hazard perception test or use scenes from a roadway?

4.7. Medium of the training

It is suggested that a final training package could be multi-format. It is emphasised that an at-home complete-in-your-own-time style format should lie at the heart of any future training. The main training therefore could be completed at home, possibly on a tablet or computer format, but that the data could be kept in the cloud for access (with the permission of the participants or users themselves) by trained driving instructors to help with additional expert training as appropriate, for example at an assessment centre with access to driving simulator, for example. One issue with this would be privacy and potential for police or insurance companies to access such data which would be of concern to users. This would have to be negotiated a-priori and exemplars from the insurance world and fleet training are in development. Another issue is the importance of older people being able to interact without necessary recourse to expensive new equipment. Hence, the training could have different versions for different formats, beginning with low-tech pen and paper solutions, through computer and tablet formats to ones that sat within different formats (for example vehicle-to home- to phone communication).

4.8. Inclusive design

It cannot be emphasised enough how important inclusive design would be, with the need to develop such training along with older people themselves to closely identify their needs and issues. Special concentration is needed on the user interface in whatever format is chosen for ease of use, with perhaps bespoke changes allowed to make the interface as usable as possible.

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