This is the peer reviewed author accepted manuscript (post print) version of a published work that appeared in final form in:

Spargo, Claire, Laver, Kate, Berndt, Angela, Adey-Wakeling, Zoe, George, Stacey 2021 'Occupational therapy interventions to improve driving performance in older people with mild cognitive impairment or early-stage dementia: a systematic review', *American Journal of Occupational Therapy*, vol. 75, no. 5, pp. 1-14

This un-copyedited output may not exactly replicate the final published authoritative version for which the publisher owns copyright. It is not the copy of record. This output may be used for non-commercial purposes.

The final definitive published version (version of record) is available at:
https://doi.org/10.5014/ajot.2021.042820

Persistent link to the UniSA Research Outputs Repository:
https://researchoutputs.unisa.edu.au/11541.2/26439

General Rights
Copyright and moral rights for the publications made accessible in the UniSA Research Outputs Repository are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognize and abide by the legal requirements associated with these rights.

- Users may download and print one copy for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the persistent link identifying the publication in the UniSA Research Outputs Repository

If you believe that this document breaches copyright, please contact us and provide details. We will remove access to the work immediately and investigate your claim.

Title: A systematic review of occupational therapy interventions to improve driving performance in older people with early stage dementia or mild cognitive impairment

Authors:

Ms Claire Spargo[1]

Associate Professor Kate Laver[2]

Dr Angela Berndt[3]

Dr Zoe Adey-Wakeling[2,4]

Professor Stacey George[1]*

[1] Caring Futures Institute, College of Nursing and Health Sciences, Flinders University, Adelaide, Australia

[2] Flinders Health and Medical Research Institute, College of Medicine and Public Health, Flinders University, Adelaide, Australia

[3]University of South Australia, Allied Health and Human Performance, Adelaide, Australia

[4]Rehabilitation Aged and Palliative Care, Flinders Medical Centre, Adelaide, Australia

*Corresponding author

Professor Stacey George, Occupational Therapy, College of Nursing and Health Sciences, Flinders University, Sturt Building N219, PCPO Box 2100, Adelaide, SA, 5001 Phone: +61 8 72218287 Stacey.george@flinders.edu.au.

Abstract:

Importance

For a person with early stage dementia or mild cognitive impairment (MCI) driving is important for independence. However, with the person's ability to drive safely potentially impacted, this poses concern for both the person and family members. It is important to determine whether occupational therapy interventions can prolong safe driving.

Objective

To determine the effectiveness of occupational therapy interventions to improve driving performance in older people with early stage dementia or MCI.

Data Sources

A search of MEDLINE, PsycINFO, CINAHL and gray literature using Google Scholar was conducted up to May 2020.

Study Selection and Data Collection

Studies were included if they evaluated interventions which aimed to improve driving performance of older people (mean age $\geq$ 60) with MCI/early stage dementia; and could be designed or delivered by an occupational therapist who specializes in driving. Citations were reviewed independently by two authors and quality appraisal was conducted using the Cochrane Risk of Bias Guidelines.

Findings

One level I randomized controlled trial (RCT) and four level III quasi-experimental studies were included with 188 participants in total (reported mean age 65.6-72.5 years). One study evaluated a compensatory approach whereas the others evaluated a remedial approach. Studies used different measures to assess outcomes and reported mixed effects.

Conclusions and Relevance

Low level evidence suggests that occupational therapy interventions may improve the driving performance of older people with MCI and early stage dementia. More RCTs that include long term follow up measures and address clinically important outcomes are needed.

What This Article Adds

In the absence of conclusive evidence from research studies and best practice guidelines occupational therapists must rely on their clinical experience and client abilities. Development of evidence and guidelines in this area are critical. It is also important for occupational therapists to work closely with clients, families and interdisciplinary team members to carefully monitor fitness to drive.

PROSPERO Registration: CRD42019111294

Background:

It is estimated that 46.8 million people worldwide live with dementia and this number is predicted to increase to 74.7 million by 2030 (Prince et al., 2015). Dementia is a syndrome characterized by a decline in multiple areas of cognitive functioning such as memory, thinking, orientation and judgement (World Health Organisation, 2016). People with dementia experience dependency in managing daily activities (Salas et al., 2010), the need for formal and informal care (Wimo, von Strauss, Nordberg, Sassi, & Johansson, 2002) and significant health care costs (Wimo et al., 2017). Mild cognitive impairment (MCI) is also common in older people, with some people later diagnosed with dementia (Mitchell & Shiri-Feshki, 2009). Unlike dementia, there is preservation of functional independence in MCI (Albert et al., 2011; Petersen et al., 1999) although research suggests that people commonly experience difficulty with instrumental activities of daily living (Jekel et al., 2015) and cognitively demanding activities such as doing two tasks at the same time (Reppermund et al., 2011). Prevalence of both MCI and dementia increase as people enter older age (Prince et al., 2012; Sachdev et al., 2015).

Driving is a complex instrumental activity of daily living (Sherman, 2006) that involves attending to the environment and integrating relevant information to plan a response (Anstey, Wood, Lord, & Walker, 2005). People with dementia have more difficulty following routes (Uc, Rizzo, Anderson, Shi, & Dawson, 2004) identifying traffic signs (Uc, Rizzo, Anderson, Shi, & Dawson, 2005) and maintaining correct lane positioning (Dawson, Anderson, Uc, Dastrup, & Rizzo, 2009) compared to healthy older adults and they drive slower than surrounding traffic (Eby, Silverstein, Molnar, Leblanc, & Adler, 2012). Guidelines developed through consensus from a team of international experts recommend that people who experience symptoms of dementia that have progressed to a ‘moderate’ stage should be

strongly discouraged from driving due to safety concerns (Rapoport et al., 2018). However, in MCI and early stage dementia the extent to which safety is impacted is less clear. Some studies have found significant impairment in the driving performance of people with MCI whilst using driving simulators (Hird et al., 2017; Pavlou et al., 2017) whereas other studies have found that most people with MCI display minor driving difficulties that have little or no impact on safety (Anstey, Eramudugolla, Chopra, Price, & Wood, 2017; Frittelli et al., 2009; Wadley et al., 2009).

Two recent systematic reviews reporting about on-road driving evaluations in people with dementia found fail rates of between 11-13.6% in people with very mild dementia and 18-33.3% in people with mild dementia (Chee et al., 2017; Hird, Egeto, Fischer, Naglie, & Schweizer, 2016). These rates were higher than that of controls (0-2%) (Chee et al., 2017; Hird et al., 2016) but nonetheless demonstrate that many people are capable of passing an on-road evaluation following a diagnosis of mild dementia. As on-road evaluation is the main method utilised in practice to inform licensing status, the results of these studies suggest that although driving performance is variable, in many cases people will continue to drive despite a diagnosis of MCI or mild dementia.

Achieving a balance between promoting driving for community participation and restricting driving due to safety concerns, presents a challenge for society. Dementia is a progressive condition and people with cognitive impairment can have a reduced ability to self-regulate their driving due to a lack of insight (Wong, Smith, & Sullivan, 2012), with family members often feeling uncertain about their relative's ability to continue driving safely (Liddle et al., 2013). However, many people wish to continue driving for as long as possible, often not planning for driving cessation (Kostyniuk & Shope, 2003) which is associated with negative

outcomes such as depressive symptoms (Chihuri et al., 2016) and reduced community participation (Marottoli et al., 2000). Research findings demonstrate that people with early stage Alzheimer's disease have preserved cognitive abilities, including sustained attention (Hopper, Bayles, & Kim, 2001), and are able to learn new skills (van Halteren-van Tilborg, Scherder, & Hulstijn, 2007), which may support the learning of new driving behaviors. A rehabilitation approach to preserve safe driving performance may be beneficial for maintaining both independence and community participation.

Internationally Driver Rehabilitation Specialists (DRS's), many of whom are advanced practice occupational therapists, provide comprehensive driving evaluations and driving rehabilitation programs to people with medical conditions. Comprehensive driver evaluations are conducted when there is uncertainty about the extent to which a person's functional limitations impact on their ability to drive. They typically include a clinical component to assess the person's visual-perceptual, physical and cognitive abilities and an on-road evaluation involving a specialised vehicle equipped with an emergency brake (Dickerson, 2013). Recommendations may include returning to driving, retirement from driving or driving rehabilitation, if there is potential for driving skills to be improved. Occupational therapists working as DRS's are trained to understand the impact of the specific medical condition on driving and design individualized driver rehabilitation programs. DRS' commonly use remedial interventions that involve retraining of skills to improve the driver's basic capacities/functional abilities, or compensatory interventions which involve the use of equipment/strategies to compensate for the impairment (Di Stefano & Macdonald, 2006). Previous systematic reviews have examined occupational therapy interventions to improve driving performance in older people and found mixed effects (Golisz 2014; Hunt & Arbesman, 2008), however, none of the interventions in these reviews were specifically

evaluated for their effectiveness for people with MCI or early stage dementia. The purpose of this systematic review was to describe the effectiveness of occupational therapy interventions to improve the driving performance of older people with early stage dementia or MCI.

Method:

Protocol and registration

This review was registered on PROSPERO on 20/02/2019 CRD42019111294

Search strategy

An electronic database search of MEDLINE, PsycINFO and CINAHL (presented in Table 1) and a gray literature search using a combination of relevant terms in Google Scholar was developed in consultation with a university librarian. The search was conducted on the 29th of May 2020. The reference lists of the included studies were also searched to identify any additional relevant articles. No date restrictions were placed on the searches.

Insert Table 1

Inclusion criteria

Studies were included if they met the following criteria: (1) older adults (mean age 60 and older) with MCI and/or early stage dementia; (2) an intervention was delivered which aimed to improve driving performance and could be designed or delivered by an occupational therapist who specializes in driving. Driving performance was defined as real-world or simulated driving. Non-English papers were excluded. No restrictions were imposed on the types of study designs that were included.

Data extraction and synthesis

Two authors (CS and SG) independently screened titles and abstracts and identified studies which appeared as if they may be eligible for inclusion. The full text versions of these articles were then retrieved and assessed for eligibility by two authors (CS and SG) independently.

Disagreements between the two authors were resolved through discussion and involvement of a third author where necessary. Information relating to level of evidence, study design, participants, inclusion criteria, intervention and control group, outcome measures and key results was extracted by one author (CS) and checked for accuracy by a second author (SG).

Quality assessment

Two authors (CS and SG) independently conducted assessments of the quality of the studies using the Cochrane Risk of Bias Guidelines (Higgins, 2011). Disagreements were resolved via discussion and involvement of the third author where necessary.

Analysis

The included studies were categorized according to the American Occupational Therapy Association's (AOTA) guidelines for systematic reviews level of evidence table based on the standards developed by Sackett and colleagues (1996) where levels range from level I (systematic review, randomized controlled trial) to level 5 (Case reports and expert opinion). The strength of the evidence was then described based on the guidelines of the U.S Preventive Service Task Force (2012) where strong evidence indicates two or more level I studies with consistent strong evidence from well-designed, well-conducted studies; moderate evidence indicates at least one level I high quality study or multiple moderate quality studies that provide sufficient evidence to determine effectiveness but confidence estimates are constrained; low level evidence indicates a small number of low-level studies with flaws in study design.

Results:

Study selection

The search of databases revealed 1173 articles; citations were downloaded into Endnote. Following removal of duplicates and title and abstract screening, eight potentially relevant

articles were sought for full text review. Five of these articles were assessed as meeting the inclusion criteria. The other three papers were excluded as they did not refer to participants as having a diagnosis of MCI or early stage dementia. No additional eligible studies were identified through gray literature or reference list searching. The PRISMA flow diagram is presented in Figure 1.

Insert Figure 1

Study characteristics

Characteristics of included studies are presented in Table 2. We identified one level I RCT that was conducted in Japan and four level III studies of quasi-experimental design that were conducted in the United States, Canada and Australia. Three studies included participants with MCI (Shimada et al., 2018; Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016), one study included participants with very mild or mild dementia (Ott, Davis, & Bixby, 2017) and one study included participants with a diagnosis of either mild Alzheimer's disease or MCI due to Alzheimer's disease (Yi, Lee, Parsons, & Falkmer, 2015). The RCT involved 160 participants whereas sample sizes in the other studies ranged from 12-28. Participants allocated to the intervention group within the randomized trial received a remedial intervention consisting of on-road training sessions, classroom vision training and driving simulator training sessions. Three other level III studies tested remedial interventions which included driving simulator training sessions (Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016) and the provision of tailored feedback using video-taped footage of real-life unsafe driving events (Ott et al., 2017). One study (Yi et al., 2015) used a compensatory approach involving the trialling of three different GPS conditions (audio only, audio-visual and visual only) to assist participants with following a route whilst using a driving simulator. One study included a

single 45-minute single intervention session (Yi et al., 2015) whereas the other studies included multiple intervention sessions ranging from 5 sessions over 21 days (Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016) to 20 sessions (Shimada et al., 2018) or multiple contacts (Ott et al., 2017) over 3 months.

Insert Table 2

Risk of bias

The quality appraisal results of studies are presented in Table 3. The RCT was generally considered to be at low risk of bias however it is unclear whether allocation was adequately concealed. The quality of the other studies was variable. There was significant clinical heterogeneity between studies in regards to the types of interventions, outcomes and comparison intervention. Thus, it was inappropriate to pool data.

Insert Table 3

Effects of interventions

Pass vs. fail rate of an on-road driving evaluation

No studies reported on pass/fail rates of on-road evaluations.

Real world driving performance indicators

Two studies reported on real world driving indicators (Ott et al., 2017; Shimada et al., 2018). Shimada and colleagues (2018) reported that a combination of on-road training sessions, classroom vision training and driving simulator training sessions resulted in a significantly increased safe driving skill score, less critical errors (minor to major difficulties) and less dangerous driving events (serious traffic violations), when assessed during an on-road evaluation with a driving instructor compared with attending a single classroom education session. Ott and colleagues (2017) reported that the provision of feedback using video-taped footage of participants real-life driving performance lead to fewer unsafe driving events and

these events were judged to be less dangerous than those which were demonstrated at baseline. Improvements were maintained during the two-month follow up phase where video footage was recorded but no feedback was provided. Improvements were reported across 13 different driving behaviour areas, including scanning at intersections, judgement, not looking far enough ahead, rolling signs and distracted driving.

Driving simulator performance indicators

Two studies (Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016) tested the effect of five driving simulator training sessions on driving simulator performance. Teasdale and colleagues (2016) found that participants with MCI demonstrated significant improvements in speeding, use of the turn signal, verification of the blind spot, tailgating and improved braking. No significant improvements were found in stopping for a red light or making an incomplete stop at an intersection. Similarly, in another study led by the same author, Teasdale et al. (2016) found a decrease in the mean number of errors that occurred across the training sessions. Over time there were significant improvements in speeding, weaving, omitting to verify a blind spot, visual search at intersections with a stop sign, and vehicle control at intersections with a stop sign. Performance for tailgating, vehicle control at intersections with a traffic light or omitting to indicate a lane change did not change over time. Effects of the intervention were not sustained at the six-month follow up assessment. The remaining study (Yi et al., 2015) found that participants demonstrated safer driving simulator behaviours when using audio GPS cues compared with when they used visual cues or audio-visual cues. Participants also demonstrated an improved ability to complete the route when using audio cues or audio-visual cues compared with visual only cues.

Additional outcomes

As abovementioned Shimada and colleagues (2018) found that intervention resulted in improved on-road abilities. They also found improved dynamic vision, measured using a dynamic visual analyzer. However, they found no difference between groups on cognitive measures using the National Center for Geriatrics and Gerontology Functional Assessment Tool (NCGG-FAT) to measure word memory scores, a tablet version of the Symbol Digit Substitution Test (Wechsler, 1955) and the Trail Making Test Parts A and B (Reitan, 1958). Two studies (Yi et al., 2015; Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016) reported that some of the participants withdrew from the trials due to driving simulator sickness. One study (Yi et al., 2015) reported that more serious driving simulator errors, such as crashing into cars and pedestrians, occurred whilst participants were observing visual cues on their GPS displays. No other studies reported a significant decline in driving performance or adverse effects related to study participation.

Discussion:

This review included one level I study and four level III studies that examined the effectiveness of occupational therapy interventions to improve driving performance in older people with MCI and early stage dementia. Studies that tested remedial interventions (Ott et al., 2017; Shimada et al., 2018) reported improvement in real world driving performance indicators, such as improved driving performance in an on-road evaluation. They also reported improvements in some, but not all, driving simulator performance indicators (Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016). One of these studies (Shimada et al., 2018) also reported improved dynamic vision. The remaining study (Yi et al., 2015) used a compensatory approach with participant's demonstrating improved safety when using audio GPS cues to complete a route using a driving simulator. Furthermore, participants demonstrated an improved ability to complete the route successfully when using audio only or audio-visual GPS cues. It is unclear

whether occupational therapy interventions influence pass/fail rates of on-road evaluation in this cohort because this was not measured in the included studies. Overall, there was low level evidence supporting the effectiveness of interventions to improve the driving performance of older people with MCI and early stage dementia.

A number of different driving performance error types reported in the studies were amenable to improvement, suggesting that remediation of both habit-based errors (e.g. omitting to verify a blind spot) and more hazardous errors (e.g. impaired visual search at intersections with a stop sign) may be possible. One interesting finding in the randomised trial by Shimada and colleagues (2018) was that there was no improvement in dangerous errors for participants with low driving skills. It is possible that people with low baseline driving performance may not be capable of improving through intervention and for these people driving cessation rather than retraining may need to be considered, particularly if the underlying cause for the impairment is progressive. Another factor to consider when determining whether an individual may benefit from interventions is working memory capabilities, which was found by Yi and colleagues (2015) to be significantly associated with participants' way finding ability when using GPS. Additional factors which may influence whether a person may benefit from an intervention, such as the level of insight into the driving performance difficulties, were not measured in the included studies.

Family members were involved in the intervention of one study (Ott et al. 2017) where heightened caregiver safety awareness was considered an important safety outcome in itself. Findings suggested that family involvement both supported driving cessation for those who demonstrated unsafe driving behaviours and promoted safer driving for those who continued

297 to drive. However, this needs careful consideration as it may result in an increased burden on
298 the family.
299
300 Interventions in the majority of the studies (Ott et al., 2017; Shimada et al., 2018; Teasdale,
301 Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon,
302 Moszkowicz, et al., 2016) were tailored to the characteristics of each participant's driving
303 performance. Individualized tailoring of intervention is likely to be important for learning
304 given that considerable individual variation in driving performance is reported by Ott and
305 colleagues (2017) and similarly by Anstey and colleagues (2017). Interventions that involved
306 retraining of driving skills were also delivered over multiple sessions (5 or more sessions)
307 which may potentially facilitate skill learning through repetition (van Halteren-van Tilborg et
308 al., 2007). These are promising intervention characteristics which should be examined in
309 future studies.
310
311 Examination of driving interventions in the broader literature can be considered for the
312 application to people with early stage dementia and MCI. Driving simulators, which provide
313 repeatable driving situations (Classen & Brooks, 2014) are a potentially viable future avenue
314 for achieving high dosages of driving skill retraining, and have demonstrated some
315 improvements in driving in the traumatic brain injury population. However, research studies
316 must evaluate whether skills learnt in driving simulators transfer to the on-road environment,
317 and also evaluate the effectiveness of the components of simulator interventions, including
318 the type of simulator, the intervention program and who delivers the program (George &
319 Perrelle, 2017) for people with early stage dementia and MCI.
320

One intervention approach that warrants further research (with larger trials) is the provision of video feedback which may enhance participation in driving interventions by supporting people to develop self-awareness of their driving performance difficulties. With recent technological advances, compensatory approaches such as audio GPS cues or the use of semi-autonomous vehicles to address individual driving performance difficulties in an on-road environment are also important areas for future research (Knoefel, Wallace, Goubran, Sabra, & Marshall, 2019).

Interestingly, few of the studies reported on the involvement of interdisciplinary team work. It is widely recognised that clinicians with different professional backgrounds working towards common aims as part of interdisciplinary teams bring high levels of knowledge and expertise to rehabilitation settings. Interdisciplinary team work is particularly important for dementia care given the complexity of the condition and the need to consider the impact of the symptoms on both the person and their caregivers (Crooks & Geldmacher, 2004). There is a paucity of research relating to interdisciplinary teamwork in driving rehabilitation for people with MCI and early stage dementia.

Study limitations included lack of randomization (Ott et al., 2017; Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016; Yi et al., 2015), lack of a control group (Ott et al., 2017; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016; Yi et al., 2015) and small sample sizes (Ott et al., 2017; Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016; Yi et al., 2015). Two studies (Shimada et al., 2018; Teasdale, Simoneau, Hudon, Moszkowicz, et al., 2016) did not include longer term follow up assessments after interventions, which is a notable limitation given that testing whether the

effects of the intervention (i.e. learning) can be maintained over time is important for determining the clinical significance of the intervention for people with MCI and dementia who commonly have memory difficulties. One study (Teasdale, Simoneau, Hudon, Germain Robitaille, et al., 2016) did not report adverse events such as rates of driving simulator sickness which is known to affect older adults (Keshavarz, Ramkhalawansingh, Haycock, Shahab, & Campos, 2018).

Included studies in this review reported a range of outcome measures, mostly developed locally for on-road or simulator use, with limited detail of their psychometric properties. It would be beneficial for future research to develop a standardized approach to the measurement of driving outcomes in occupational therapy, enabling consolidation of knowledge, using meta-analyses, to inform evidence-based practice.

This review builds on two previous systematic reviews related to occupational therapy and driving, by specifically examining people with MCI or early stage dementia. Firstly, Golisz (2014) conducted a systematic review of occupational therapy interventions to improve driving performance in older adults and found low to moderate positive effects of interventions. A number of the interventions that were examined were similar to those used in in the current review (e.g. coaching and feedback on performance using simulator or behind the wheel training). Secondly, a broader systematic review that examined driver rehabilitation occupational therapy interventions (Unsworth & Baker, 2014) similarly found some limited evidence to support the effectiveness of computer-based driving simulator training and off-road skill specific training in improving on-road fitness to drive for older people.

With an international commitment to increasing dementia research (World Health Organization, 2017), in the context of the prevalence of dementia and MCI and forecasts of a rapidly ageing population worldwide, consideration of driving remediation or compensation techniques is greatly important. Finding a balance between public safety and the maintenance of driving where possible for people with MCI and dementia is critically important. Effectively prolonging safe driving performance in people with early stage dementia or MCI has the potential to have a significant effect for the individual (improved community participation, reduced loneliness) and caregiver (improved well-being), and also a broader societal economic impact due to reduced reliance on formal services.

This review included a comprehensive search of both electronic databases and grey literature. Articles were restricted to English, which is a limitation, however title and abstract screening of non-English studies did not identify any that met the inclusion criteria. The main limitation of this review was that participants in most of the included studies had a diagnosis of either of MCI or Alzheimer's disease meaning few other types of dementia (e.g. vascular dementia) were captured, thus the effects of intervention for these subtypes are largely unknown. Yet, people with other types of early stage dementia, who may experience physical or behavioural symptoms along with cognitive changes, are at a greater risk of unsafe driving than people with Alzheimer's disease (Toepper & Falkenstein, 2019) and may be less likely to benefit from intervention.

Implications for occupational therapy research

The findings of this systematic review have the following implications for future research:

- More RCT's, with adequate power, that include long term follow up measures and address clinically important outcomes such as the ability to pass or fail a driving evaluation are needed
- Further exploration into the potential benefits of tailored, multi-session interventions with caregiver involvement and interdisciplinary teamwork is needed
- Further research identifying the factors, such as level of insight into driving performance or retained working memory, that influence the ability of the person with MCI or early stage dementia to benefit from an intervention is required

Implications for occupational therapy practice:

The findings of this review have the following implications for occupational therapy practice:

- In the absence of conclusive high level research evidence to support the use of occupational therapy interventions to improve the driving performance of older people with early stage dementia or MCI, occupational therapists must rely on their clinical experience and consideration of the person's abilities. They should also work with the person, family members and interdisciplinary team members to carefully monitor driving fitness.

Conclusion:

This review found low level evidence suggesting that occupational therapy interventions may improve the driving performance of older people with MCI and early stage dementia. The clinical significance and long-term effects of the interventions is not yet known therefore careful monitoring of the driving performance of people with MCI and dementia is required

References

Albert, M. S., Dekosky, S. T., Dickson, D., Dubois, B., Feldman, H. H., Fox, N. C., . . . Phelps, C. H. (2011). The diagnosis of mild cognitive impairment due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association, 7*(3), 270-279. doi:10.1016/j.jalz.2011.03.008

Anstey, K. J., Eramudugolla, R., Chopra, S., Price, J., & Wood, J. M. (2017). Assessment of driving safety in older adults with mild cognitive impairment. *Journal of Alzheimer's Disease*, *57*(4), 1197-1205. doi:10.3233/JAD-161209

Anstey, K. J., Wood, J., Lord, S., & Walker, J. G. (2005). Cognitive, sensory and physical factors enabling driving safety in older adults. *Clinical Psychology Review*, *25*(1), 45-65. doi:10.1016/j.cpr.2004.07.008

Chee, J. N., Rapoport, M. J., Molnar, F., Herrmann, N., Apos, Neill, D., . . . Carr, D. B. (2017). Update on the risk of motor vehicle collision or driving impairment with dementia: a collaborative international systematic review and meta-analysis. *The American Journal of Geriatric Psychiatry, 25*(12), 1376-1390. doi:10.1016/j.jagp.2017.05.007

Chihuri, S., Mielenz, T. J., Dimaggio, C. J., Betz, M. E., Diguiseppi, C., Jones, V. C., & Li, G. (2016). Driving cessation and health outcomes in older adults. *Journal of the American Geriatrics Society, 64*(2), 332-341. doi:10.1111/jgs.13931

Crooks, E. A., & Geldmacher, D. S. (2004). Interdisciplinary approaches to Alzheimer's disease management. *Clinics in Geriatric Medicine, 20*(1), 121-139. doi:10.1016/j.cger.2003.11.004

Dawson, D. J., Anderson, W. S., Uc, Y. E., Dastrup, Y. E., & Rizzo, Y. M. (2009). Predictors of driving safety in early Alzheimer disease. *Neurology, 72*(6), 521-527. doi:10.1212/01.wnl.0000341931.35870.49

Di Stefano, M., & Macdonald, W. (2006). Advanced strategies for on-road driver rehabilitation and training. In K. Falk (Ed.), *Driver rehabilitation and community mobility principles and practice* (pp. 297-308). St Louis, MO: Elsevier Mosby.

Dickerson, A. E. (2013). Driving assessment tools used by driver rehabilitation specialists: Survey of use and implications for practice. *American Journal of Occupational Therapy, 67*(5), 564-573. doi: 10.5014/ajot.2013.007823

Eby, D. W., Silverstein, N. M., Molnar, L. J., Leblanc, D., & Adler, G. (2012). Driving behaviors in early stage dementia: a study using in-vehicle technology. *Accident Analysis and Prevention, 49*, 330-337. doi:10.1016/j.aap.2011.11.021

Frittelli, C., Borghetti, D., Iudice, G., Bonanni, E., Maestri, M., Tognoni, G., . . . Iudice, A. (2009). Effects of Alzheimer's disease and mild cognitive impairment on driving ability: a controlled clinical study by simulated driving test. *International Journal of Geriatric Psychiatry, 24*(3), 232-238. doi:10.1002/gps.2095

George, S., & Perrelle, N. (2017). Simulator-based occupational therapy driving intervention can reduce driving errors on a simulator-based driving assessment in combat veterans with polytrauma. *Australian Occupational Therapy Journal, 64*(6), 512-513. doi:10.1111/1440-1630.12435

Golisz, K. (2014). Occupational therapy interventions to improve driving performance in older adults: A systematic review. *American Journal of Occupational Therapy, 68*(6), 662-669. doi: 10.5014/ajot/2014.011247

Higgins, J. P. T., Green, S. (Eds). (2011). *Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1.0* Retrieved from https://handbook-5-1.cochrane.org/

Hird, M. A., Egeto, P., Fischer, C. E., Naglie, G., & Schweizer, T. A. (2016). A systematic review and meta-analysis of on-road simulator and cognitive driving assessment in Alzheimer's disease and mild cognitive impairment. *Journal of Alzheimer's disease, 53*(2), 713-729. doi: 10.3233/JAD-160276

Hird, M. A., Vesely, K. A., Fischer, C. E., Graham, S. J., Naglie, G., & Schweizer, T. A. (2017). Investigating simulated driving errors in amnestic single- and multiple-domain mild cognitive impairment. *Journal of Alzheimer's Disease, 56*(2), 447-452. doi:10.3233/JAD-160995

Hopper, T. A., Bayles, K. A., & Kim, E. A. (2001). Retained neuropsychological abilities of individuals with alzheimer's disease. *Seminars In Speech And Language, 22*(4), 261-274. doi:10.1055/s-2001-17425

Hunt, L. A., & Arbesman, M. (2008). Evidence-based and occupational perspective of effective interventions for older clients that remediate or support improved driving performance. *American Journal of Occupational Therapy, 62*(2), 136-148. doi:10.5014/ajot.62.2.136

Jekel, K., Damian, M., Wattmo, C., Hausner, L., Bullock, R., Connelly, P. J., . . . Salmon, E. (2015). Mild cognitive impairment and deficits in instrumental activities of daily living: a systematic review. *Alzheimer's Research & Therapy, 7*, 17-37. doi: 10.1186/s13195-015-0099-0

Keshavarz, B., Ramkhalawansingh, R., Haycock, B., Shahab, S., & Campos, J. (2018). Comparing simulator sickness in younger and older adults during simulated driving under different multisensory conditions. *Transportation Research Part F: Traffic Psychology and Behaviour, 54*, 47-62. doi: 10.1016/j.trf.2018.01.007.

Knoefel, F., Wallace, B., Goubran, R., Sabra, I., & Marshall, S. J. G. (2019). Semi-autonomous vehicles as a cognitive assistive device for older adults. *Geriatrics, 4*(4), 63-77. doi:https://doi.org/10.3390/geriatrics4040063

Kostyniuk, L. P., & Shope, J. T. (2003). Driving and alternatives: Older drivers in Michigan. *Journal of Safety Research, 34*(4), 407-414. doi:10.1016/j.jsr.2003.09.001

Liddle, J., Bennett, S., Allen, S., Lie, D. C., Standen, B., & Pachana, N. A. (2013). The stages of driving cessation for people with dementia: needs and challenges. *International psychogeriatrics, 25*(12), 2033-2046. doi:10.1017/S1041610213001464

Marottoli, R. A., de Leon, C. F. M., Glass, T. A., Williams, C. S., Cooney, L. M., & Berkman, L. F. (2000). Consequences of driving cessation. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 55*(6), S334-S340. doi:10.1093/geronb/55.6.S334

Mitchell, A. J., & Shiri-Feshki, M. (2009). Rate of progression of mild cognitive impairment to dementia–meta-analysis of 41 robust inception cohort studies. *Acta Psychiatrica Scandinavica, 119*(4), 252-265. doi:10.1111/j.1600-0447.2008.01326.x

*Ott, B. R., Davis, J. D., & Bixby, K. (2017). Video feedback intervention to enhance the safety of older drivers with cognitive impairment. *American Journal of Occupational Therapy, 71*(2), 1-7. doi:10.5014/ajot.2017.020404

Pavlou, D., Papadimitriou, E., Antoniou, C., Papantoniou, P., Yannis, G., Golias, J., & Papageorgiou, S. G. (2017). Comparative assessment of the behaviour of drivers with mild cognitive impairment or Alzheimer's disease in different road and traffic conditions. *Transportation research part F: Traffic Psychology and Behaviour, 47*, 122-131. doi:10.1016/j.trf.2017.04.019

Petersen, R. C., Smith, G. E., Waring, S. C., Ivnik, R. J., Tangalos, E. G., & Kokmen, E. (1999). Mild cognitive impairment: clinical characterization and outcome. *Archives of Neurology, 56*(3), 303-308. doi:10.1001/archneur.56.3.303

Prince, M., Bryce, R., Albanese, E., Wimo, A., Ribeiro, W., & Ferri, C. (2012). The global prevalence of dementia: A systematic review and metaanalysis. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association, 9*(1), 63-75. doi:10.1016/j.jalz.2012.11.007

Prince, M., Wimo, A., Guerchet, M., Ali, G.-C., Wu, Y.-T., & Prina, M. (2015). *World Alzheimer Report*. Retrieved from Alzheimer's Diesease International: https://www.alz.co.uk/research/world-report-2015

Rapoport, M., Chee, J., Carr, D., Molnar, F., Naglie, G., Dow, J., . . . O'Neill, D. (2018). An international approach to enhancing a national guideline on driving and dementia. *Current Psychiatry Reports, 20*(3), 1-9. doi:10.1007/s11920-018-0879-x

Reitan, R. M. (1958). Validity of the trail making test as an indicator of organic brain damage. *Perceptual and Motor Skills, 8*(3), 271-276.

Reppermund, S., Sachdev, P. S., Crawford, J., Kochan, N. A., Slavin, M. J., Kang, K., . . . Brodaty, H. (2011). The relationship of neuropsychological function to instrumental activities of daily living in mild cognitive impairment. *International Journal of Geriatric Psychiatry, 26*(8), 843-852. doi:10.1002/gps.2612

Sachdev, P. S., Lipnicki, D. M., Kochan, N. A., Crawford, J. D., Thalamuthu, A., Andrews, G., . . . Santabárbara, J. (2015). The prevalence of mild cognitive impairment in diverse geographical and ethnocultural regions: The COSMIC collaboration (mild cognitive impairment internationally). *10*(11), e0142388. doi:10.1371/journal.pone.0142388

Sackett, D. L., Rosenberg, W. M., Gray, J. M., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: what it is and what it isn't. *British Medical Journal, 312*(7023), 71-72. doi: 10.1136/bmj/312.7023.71

Salas, A., Rodriguez, J., Pichardo, G., Liu, Z., Hernandez, M., Jacob, K. S., . . . Prince, M. (2010). "The contribution of chronic diseases to the prevalence of dependence among older people in Latin America, China and India: a 10/66 dementia research group population-based survey". *BMC Geriatrics, 10*(1), 53. doi:10.1186/1471-2318-10-53

Sherman, F. (2006). Driving: the ultimate IADL. *Geriatrics, 61*(10), 9-10. doi:10.1021/jp061648m

*Shimada, H., Hotta, R., Makizako, H., Doi, T., Tsutsumimoto, K., Nakakubo, S., & Makino, K. (2018). Effects of driving skill training on safe driving in older adults with mild cognitive impairment. *Gerontology, 65*(1), 90-97. doi:10.1159/000487759

*Teasdale, N., Simoneau, M., Hudon, L., Germain Robitaille, M., Moszkowicz, T., Laurendeau, D., . . . Hudon, C. (2016). Older adults with mild cognitive impairments show less driving errors after a multiple sessions simulator training program but do not exhibit long term retention. *Frontiers in Human Neuroscience, 10*, 653. doi: 10.3389/fnhum.2016.0065

*Teasdale, N., Simoneau, M., Hudon, L., Moszkowicz, T., Laurendeau, D., Germain Robitaille, M., . . . Hudon, C. (2016). Drivers with amnestic mild cognitive impairment can benefit from a multiple-session driving simulator automated training program. *Journal of the American Geriatrics Society, 64*(9), 16-18. doi: 10.1111/jgs.14219

Toepper, M., & Falkenstein, M. (2019). Driving fitness in different forms of dementia: An update. *Journal of the American Geriatrics Society, 67*(10), 2186-2192. doi:10.1111/jgs.16077

U.S. Preventive Services Task Force. (2012). Grade definitions. Retrieved from https://www.uspreventiveservicestaskforce.org/Page/Name/grade-definitions

Uc, E., Rizzo, M., Anderson, S., Shi, Q., & Dawson, J. D. (2004). Driver route-following and safety errors in early Alzheimer disease. *Neurology, 63*(5), 832-837. doi:10.1212/01.WNL.0000139301.01177.35

Uc, E., Rizzo, M., Anderson, S., Shi, Q., & Dawson, J. D. (2005). Driver landmark and traffic sign identification in early Alzheimer's disease. *Journal of Neurolology, Neurosurgery & Psychiatry, 76*(6), 764-768. doi:10.1136/jnnp.2004.049338

Unsworth, C. A., & Baker, A. (2014). Driver rehabilitation: A systematic review of the types and effectiveness of interventions used by occupational therapists to improve on-road fitness-to-drive. *Accident Analysis & Prevention, 71*, 106-114. doi 10.1016/j.aap.2014.04.017

van Halteren-van Tilborg, I. A., Scherder, E. J., & Hulstijn, W. (2007). Motor-skill learning in alzheimer's disease: a review with an eye to the clinical practice. *Neuropsychology Review, 17*(3), 203-212. doi: 10.1007/s11065-007-9030-1

Wadley, V. G., Okonkwo, O., Crowe, M., Vance, D. E., Elgin, J. M., Ball, K. K., & Owsley, C. (2009). Mild cognitive impairment and everyday function: An investigation of driving performance. *Journal of Geriatric Psychiatry and Neurology, 22*(2), 87-94. doi:10.1177/0891988708328215

Wechsler, D. (1955). *Manual for the Wechsler Adult Intelligence Scale*. Oxford, England: Psychological Corp.

Wimo, A., Guerchet, M., Ali, G.-C., Wu, Y.-T., Prina, A. M., Winblad, B., . . . Prince, M. (2017). The worldwide costs of dementia 2015 and comparisons with 2010. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association, 13*(1), 1-7. doi:10.1016/j.jalz.2016.07.150

Wimo, A., von Strauss, E., Nordberg, G., Sassi, F., & Johansson, L. (2002). Time spent on informal and formal care giving for persons with dementia in sweden. *Health Policy, 61*(3), 255-268. doi:10.1016/S0168-8510(02)00010-6

Wong, I. Y., Smith, S. S., & Sullivan, K. A. (2012). The relationship between cognitive ability, insight and self-regulatory behaviors: findings from the older driver population. *Accident Analysis and Prevention, 49*, 316-321. doi: 10.1016/j.aap.2012.05.031

World Health Organisation. (2016). *International Statistical Classification of Diseases and Related Health Problems 10th Revision* (ICD-10) *version: 2016*. Retrieved from: https://icd.who.int/browse10/2016/en#/F03

World Health Organization. (2017). *Global action plan on the public health response to dementia 2017–2025*. Retreived from: https://www.who.int/mental_health/neurology/dementia/action_plan_2017_2025/en/

*Yi, J., Lee, H. C.-Y., Parsons, R., & Falkmer, T. (2015). The effect of the global positioning system on the driving performance of people with mild Alzheimer's disease. *Gerontology, 61*(1), 79-88. doi: 10.1159/00036592 2