
Evidence-Based and Occupational Perspective of Effective Interventions for Older Clients That Remediate or Support Improved Driving Performance

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KEY WORDS

- driving
- fitness to drive
- older drivers
- rehabilitation

To assess the effectiveness of person-related interventions on driving ability in older adults, this literature review was completed as a part of the Evidence-Based Literature Review Project of the American Occupational Therapy Association. Nineteen articles were incorporated into the systematic review and include interventions in the following areas: visual, cognitive, and motor; educational; passengers; and medical. The results provide inconclusive evidence for the use of interventions such as the Useful Field of View training, home exercise programs stressing self-awareness of driving skills and that some medical interventions affect the ability to drive. Despite limitations, the studies reviewed provide useful information that deserves further exploration. Reading the literature provides therapists with knowledge that might improve client care. Learning about cutting-edge interventions and educating peers and students about evidence-based interventions may lead to safer community mobility for older adults

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Safe driving requires that a person's skills be at the appropriate levels to interact with an environment that is changing and unpredictable. For older adults, the occupation of driving and community mobility may be impaired by the aging process, disease process, or injury. According to the *Occupational Therapy Practice Framework: Domain and Process*, "Occupational therapists and occupational therapy assistants recognize that health is supported and maintained when individuals are able to engage in occupations and in activities that allow desired or needed participation in home, school, workplace, and community life situations" (American Occupational Therapy Association [AOTA], 2002, p. 611). Driving and community mobility, both instrumental activities of daily living (IADLs), are in the domain of the occupational therapy profession because they allow engagement in daily life activities. Practice requires using interventions that address clients' performance skills (cognitive, visual, motor); performance patterns (self-regulation, self-awareness); context or contexts (role of passengers, family involvement); and activity demands (adaptive devices and strategies) to improve clients' abilities.

Statement of Problem

Currently, occupational therapists and occupational therapy assistants may not know where to find evidence, do not have the time to access evidence, and do not have incentives to find and use the evidence developed by other disciplines. In addition, the existing evidence has been published in a broad array of professional journals that

may not be accessible to occupational therapists. The articles in this issue provide valuable information for practitioners by selecting only the strongest research and interpreting it. To achieve the goal of best practice, clinical and community-based occupational therapists and occupational therapy assistants need evidence-based findings to guide the process or interventions related to the domain of driving and community mobility. The evidence-based interventions presented in this article address specific aspects of performance presented in the *Occupational Therapy Practice Framework* (AOTA, 2002). Older adults' abilities to drive and maintain community mobility may depend on occupational therapist' ability to use evidence-based interventions that focus on visual, cognitive, motor functions, and client–family educational programs.

Moreover, educators are obliged to teach occupational therapy and occupational therapy assistant students current best practice and to promote the advancement of factual knowledge. This evidence-based literature review may provide the resources to achieve that goal. In addition, this article provides foundational research that may be developed into new theories for intervention.

Background Literature

Researchers in a variety of fields have examined the skills required to drive a motor vehicle. Demands on attention, visuospatial abilities, motor programming and function, judgment, memory, sequencing, and information processing have been well documented (Anstey, Wood, Lord, & Walker, 2005; Duchek, Hunt, Ball, Buckles, & Morris, 1997; Owsley, 1994; Perryman & Fitten, 1996; Richardson & Marottoli, 2003; Staplin, Gish, & Wagner, 2003). Moreover, Anstey et al. (2005) found that attention, reaction time, memory, executive function, mental status, visual function, and physical function variables were skills associated with driving outcome measures. In addition, other research has examined the impact of age-associated changes on older adults' driving performance. For example, Owsley (1994) found that older drivers with visual–sensory impairment, cognitive impairment, or reduced useful field of view were at greater risk for crashes than were those without these problems. Owsley et al. (2002) also found that eye health affected older drivers' driving ability. In addition, Duchek et al. (1997) documented that visual search and reaction time were predictive of driving performance.

Driving skills may be compromised by aging; eye disease; neurological disorders such as stroke, dementia, and Parkinson's disease; or other conditions such as arthritis, diabetes, or cardiovascular diseases (Wang, Kosinski, Schwartzberg, & Shanklin, 2003; Yale, Hansotia, Knapp, &

Ehrfurth, 2003). Impairments in driving skills brought about by aging and health issues may lead to unsafe driving, vehicle crashes, or driving cessation. The purpose of evidence-based interventions is to remediate some of these impairments, enabling many older adults to maintain safe, active lifestyles, which is a goal of occupational therapy.

The older population is growing, and the need to assist older people with driving and community mobility is increasing rapidly. The seriousness of the combination of the increase in older drivers, the aging of the population, and health-related driving concerns is observed in the data documenting motor vehicle crashes. Motor vehicle injuries are the leading cause of injury-related deaths among 65- to 74-year-olds and are the second leading cause (after falls) among 75- to 84-year-olds (Gorina, Hoyert, Lentzner, & Goulding, 2006). Compared with other drivers, older drivers have a higher fatality rate per mile driven than any other age group except those younger than age 25. On the basis of estimated annual travel, the fatality rate for drivers ages 85 or older is 9 times higher than that for drivers 25 to 69 (National Highway Traffic Safety Administration [NHTSA], 2005).

This excess in fatalities exists for two reasons. First, drivers ages 75 or older are involved in significantly more motor vehicle crashes per mile driven than are middle-age drivers. Second, older drivers are considerably more fragile, hindering the body's ability to sustain the energy forces of a crash. Fragility begins to increase at ages 60 to 64 and increases steadily with advancing age (Evans, 2000). By age 80, male and female drivers are 4.0 and 3.1 times more likely, respectively, than 20-year-olds to die as a result of a motor vehicle crash (Evans, 2000).

In 2005, 191,000 older adults were injured in traffic crashes, accounting for 7% of all the people injured in traffic crashes during that year. These older adults made up 15% of all traffic fatalities, 14% of all vehicle occupant fatalities, and 20% of all pedestrian fatalities. Most traffic fatalities involving older drivers in 2005 occurred during the daytime (79%) or on weekdays (73%) and involved other vehicles (73%; NHTSA, 2005). As the older population in this country continues to grow, drivers ages 65 or older are alone expected to account for 16% of all crashes and 25% of all fatal crashes (Eberhard, 2001). Given these statistics and the necessity of being able to drive, it is critical that occupational therapists and occupational therapy assistants understand their role in providing evidence-based interventions that could increase and prolong safe driving, thereby reducing crashes, injuries, and fatalities in the older driver population.

Occupational therapists and occupational therapy assistants traditionally work with clients to remediate deficits in all the skills required for driving. Practitioners must examine

how they can use evidence-based interventions to improve the IADLs of driving and community mobility. Occupational therapy's domain "focuses on assisting people to engage in daily life activities that they find meaningful and purposeful" (AOTA, 2002, p. 610). Often, participation in daily life activities depends on clients' ability to drive. Using these interventions to enable older adults to drive is critical because driving is increasingly the primary mode of transportation for older adults (Rosenbloom, 1993). Furthermore, it has been shown that those without transportation have decreased life satisfaction (Taylor & Tripodes, 2001) and may become depressed, isolated, and dependent (Marottoli et al., 1997). The ability to remediate client factors helps optimize and prolong older drivers' ability to drive safely, and it increases opportunities for engagement in a range of activities from everyday activities of daily living to education, work, play, leisure, and social interactions.

NHTSA recognizes that occupational therapists have the background knowledge and skills to remediate and retrain older drivers. It also acknowledges that those who can provide these services are limited in number (Finn, 2004). This evidence-based review was developed to provide practitioners with knowledge on the effect of interventions to address cognitive and visual function; motor function; driving skills intervention; self-regulation and self-awareness; and the role of passengers and family involvement in the driving ability, performance, and safety of the older adult. Intervention approaches include adaptation, remediation, prevention, and maintenance.

Interventions, as in all occupational therapy practice, are based on evaluation. Therapists using driving intervention research will exercise good professional judgment when suggesting interventions. For example, therapists need to explore a client's occupational profile by discussing driving history and needs, driving interest and priority level, and perceived driving concerns and risks. The *Occupational Therapy Practice Framework* (AOTA, 2002) stresses that an intervention plan is developed collaboratively with the client, including, in some cases, family or significant others, which is usually the norm for older drivers.

Occupational therapists and occupational therapy assistants must keep in mind that older clients may use their own intervention strategy, typically by beginning to restrict their own driving as they begin to understand how aging or medical conditions affect their abilities (Hakamies-Blomquist, 1993; Lefrancois & D'Amours, 1997). Older drivers may drive only during the day or during nonpeak times and may limit the duration of trips. Some older drivers may be ready for others to provide transportation and do not want to invest in driving rehabilitation, or they may believe that operating a motor vehicle has become too expensive.

Occupational therapists and occupational therapy assistants must explore all options with clients. As the *Occupational Therapy Practice Framework* (AOTA, 2002) suggests, during the intervention process, continued collaboration with the client is vital. For example, clients may realize through the intervention process that driving is no longer an option; the discussion of intervention then needs to be directed toward support to engage in community mobility.

Furthermore, matching the appropriate intervention to the proper client is essential for success. For example, clients who have dementia of the Alzheimer's type or who perform poorly on cognitive tests may not respond to a particular training intervention geared to remediate problems with memory, attention, insight, judgment, and information-processing speed (Hunt, 2001). Because these clients may have difficulty recalling recent information, making decisions and judgments, processing what was said by others, and handling complex tasks, a training program may result only in frustration, not in improved driving skills. Clients with arthritis or cerebrovascular disease, however, may respond favorably to range-of-motion and strengthening programs that improve overall endurance and strength, neck and trunk rotation, and therefore driving ability (Hunt, 2001).

Although some occupational therapists and occupational therapy assistants have practiced in the domain of driving rehabilitation and community mobility for several years, very little research has been published in the occupational therapy literature. Therefore, clinical and community-based occupational therapists and occupational therapy assistants working in this area need to be familiar with relevant research from other disciplines such as medicine, psychology, and engineering. Often, they explore the professional journals and report a lack of information on driving rehabilitation, not knowing that a wealth of information is published in other disciplines. Another problem is that most therapists and occupational therapy assistants working in driving rehabilitation may have been practicing for many years and are now unfamiliar with advances regarding interventions that may improve client driving performance. The research presented here will broaden the existing narrow focus on adaptive equipment as the only intervention, which is characteristic of most driving rehabilitation programs. Occupational therapists and occupational therapy assistants must now explore with clients the full range of interventions that may improve driving skills. Thus, the purpose of this article is to

- Describe effective interventions from both occupational therapy and other disciplines that improve outcomes for older adults with driving impairments consistent with the domain of occupational therapy;

- Guide practicing occupational therapists and occupational therapy assistants in determining which interventions will have the greatest effect on their clients' ability to drive safely;
- Assist occupational therapists and occupational therapy assistants in gaining coverage for and payment of occupational therapy services by using current findings; and
- Suggest new research questions that may evolve from using evidence-based interventions.

Occupational therapists and occupational therapy assistants must act on the fact that an underlying requirement for independence is the ability to drive or move about the community freely and easily. Having the knowledge to intervene appropriately will result in a growing number of older people valuing the services provided by occupational therapists and occupational therapy assistants (Pierce & Hunt, 2005).

Methods for Conducting the Evidence-Based Review

The portion of the Older Driver Evidence-Based Literature Review reported in this article addressed the impact of person-related interventions on older adults' participation. Detailed information about the methodology for the entire Older Driver Evidence-Based Literature Review can be found in the article "Background and Methodology of the Older Driver Evidence-Based Systematic Literature Review" (Stav, Arbesman, & Lieberman, 2008) on pages 130–135.

Results

Table 1 summarizes the 19 articles reviewed for this topic and includes information about the objectives, design, procedures, findings, and limitations of the review studies. The systematic review included 10 Level I articles, 6 Level II articles, and 3 Level III articles, addressing interventions in the following areas: visual, cognitive, and motor; educational; passengers; and medical interventions. Seven studies examined the effect of visual, cognitive, and motor interventions on older adult driving.

The Useful Field of View (UFOV) test (Ball, Beard, Roenker, Miller, & Griggs, 1988) is a computer-administered and computer-scored assessment of visual attention. It measures visual processing speed, divided attention, and selective attention. Evidence is inclusive concerning the efficacy of UFOV for older adult driving performance. A Level I study by Ball et al. (1988) and a Level III pilot study by Mazer, Sofer, Korner-Bitensky, and Gelinas (2001) with participants with stroke indicated significant improvements with the use of UFOV. A Level I study by Mazer et al. (2003) compared UFOV training with computerized visuopercep-

tual training for those with stroke and found no difference between groups. There was, however, an almost twofold increase (28.6% vs. 52.4%) in the rate of success on the on-road driving evaluation after UFOV training for participants with right-sided lesions, indicating that a positive effect of UFOV training may be specific to lesion area.

The Dynavision (Performance Enterprise, Markham, Ontario, Canada) is a 5-ft × 4-ft computerized, wall-mounted board containing 64 small red square target buttons arranged in five nested rings. It was designed to train users to receive, process, and react to visual information. Specially, it uses visual search strategies, oculomotor skills, and eye–hand coordination and thereby trains peripheral visual awareness, visual attention, and muscular coordination. Insufficient evidence exists for the effects of Dynavision; one Level III study evaluated older adults with a history of stroke trained on a Dynavision (Klavora et al., 1995). The results of the study reported better performance on divided attention and selected attention tasks after training, with no improvement on speed of processing. In addition, 60% of participants earned a rating of "safe to resume driving," a recommendation for on-road driving lessons during behind-the-wheel assessments, or both compared with a previously reported success rate (without Dynavision) of 24%.

Inconclusive evidence is available from a Level I study (Ostrow, Shafran, & McPherson, 1992) that a home exercise program can improve selected driving skills. The study compared the effect of a home exercise program of back and upper body range of motion and stretching exercises to driving skills instruction in a car. The results indicated that participants following the home exercise program improved in shoulder flexibility and trunk rotation and the driving skill of observing (e.g., lane changes and mirrors).

Seven studies evaluated the effect of a variety of educational programs on driving performance. Conclusive evidence from a Level I systematic review (Ker, Roberts, Renton, & Bunn, 2003) and a Level II study (Janke, 1994) demonstrates that driver education programs have no effect on the rate of crashes and fatalities in older adults. These programs, however, do appear to result in fewer traffic citations.

Conclusive evidence demonstrates that older adults respond positively to programs stressing self-awareness of driving skills as noted in a Level II study (Stalvey & Owsley, 2003) and a Level III study (Eby, Molnar, Shope, Vivoda, & Fordyce, 2003). In addition, these programs may result in increased perception of vision impairments and a better understanding of the impact of vision impairment on driving (Eby et al., 2003). These programs did not appear to be effective, however, in altering perceived threat of crash involvement, perceived barriers to self-regulation, and perceived regulatory self-efficacy (Stalvey & Owsley, 2003),

Table 1. Evidence Table: Person-Related Interventions

Author/Year	Study Objectives	Level/Design/Participants	Intervention and Outcome Measures	Results	Limitations
Ashman et al. (1994)	Develop and evaluate the efficacy and effectiveness of an intervention to improve safety in older drivers	I—Randomized control trial; four groups with different interventions Pre-post measurement N = 105 All participants were older than age 65 and driving on a regular basis.	Group I: Home-based physical therapy to improve posture and upper-limb flexibility (8 weeks) Group II: Home-based perceptual therapy for visual-perception skills (8 weeks) Group III: Driver education program to improving driving skills (1 day for 8 hr) Group IV: Improvement in driving environment Outcome: <ul style="list-style-type: none"> ■ Drivers Performance Measurement. 	Each intervention was reported to be effective in improving driving performance by 7.9% from the baseline performance. No statistical significant difference was reported between groups; however, physical therapy was reported to be most cost-effective compared with the other interventions.	Group IV was tested three times, which may have skewed the results.
<p><i>Reference:</i> Ashman, R. D., Bishu, R. R., Foster, B. G., & McCoy, P. T. (1994). Countermeasures to improve the driving performance of older drivers. <i>Educational Gerontology, 20</i>, 567–577.</p>					
Ball et al. (1988)	Describe changes in peripheral visual field and its influence on functional vision and determine effectiveness of training in improving visual skills	I—Randomized control trial Two groups: Intervention I and Intervention II N = 24 (eight participants ages 20–30, eight participants ages 40–49, and eight participants age 60–75)	Intervention I: Training using the useful field of view (UFOV) with low distracters. Intervention II: Training using the UFOV with high distracters (five sessions)	Visual field area was reported to be more affected in older participants compared with younger ones. Improvement in performance noted after practice increased significantly for older participants, resembling that of middle-aged participants before practice.	Applicability of the training in improving visual skills for functional activities may be questionable.
<p><i>Reference:</i> Ball, K. K., Beard, B. L., Roenker, D. L., Miller, R. L., & Griggs, D. S. (1988). Age and visual search: Expanding the useful field of view. <i>Journal of Optical Society of America, 5</i>, 2210–2219.</p>					
Eby et al. (2003)	Determine whether the Driving Decisions Workbook increased self-awareness and general knowledge and was perceived as useful for participants and establish validity of the workbook in identifying driving abilities	III—Before-and-after study N = 99 participants ages 65–90 years	Driving Decisions Workbook was used to assess and get feedback from the participants about changes in driving in 37 core areas. Outcomes: <ul style="list-style-type: none"> ■ Driving Decisions Workbook ■ Road test: A 7-mile (11.3-km) road test with 28 structured maneuvers at specific locations, scored by three raters 	Awareness about changing driving abilities and physical health was reported by the participants. Additionally, 75% of the participants expressed interest in using the workbook in the future. The correlation between the overall workbook score and the overall road-test score of all participants was positively significant. When broken down by category domains for the workbook, responses for both cognition and psychomotor performance were significantly related to driving performance but only for 64- to 75-year age group.	Both the intervention and the outcomes measurement used the same Driving Decisions Workbook, which might have limited the identification of the true effect; no control group.
<p><i>Reference:</i> Eby, D. W., Molnar, L. J., Shope, J. T., Vivoda, J. M., & Fordyce, T. A. (2003). Improving older driver knowledge and self-awareness through self-assessment: The driving decisions workbook. <i>Journal of Safety Research, 34</i>, 371–381.</p>					
Hing et al. (2003)	Evaluate the impact of passengers on the safety of older drivers	II—Cohort study Crash data from Kentucky State Police reports N = 28,275 for age group 65–74 years	No intervention; observational study Outcomes: <ul style="list-style-type: none"> ■ Crash data from the Kentucky State Police Reports for 1995–1998; crashes involving drivers ages 65 and older (65–75 and 75+). ■ Single- and multivehicle crashes 	Drivers older than age 75 were involved in crashes more often than drivers ages 65–74. Older women were involved in multivehicle crashes more often than men. Drivers with two or more passenger were more likely to be involved in crashes on roads with curves and grades, except during night driving.	Eye health and other factors were not included in the analysis. Authors did not examine the potential distractions that took place during driving, only the presence or absence of passengers.
<p><i>Reference:</i> Hing, J. Y. C., Stamatidis, N., & Aultman-Hall, L. (2003). Evaluating the impact of passengers on the safety of older drivers. <i>Journal of Safety Research, 34</i>, 343–351.</p>					

Table 1. Evidence Table: Person-Related Interventions (continued)

Author/Year	Study Objectives	Level/Design/Participants	Intervention and Outcome Measures	Results	Limitations
Jacobs et al. (1997)	Determine the effectiveness of participation-oriented education in driving rehabilitation for older adults	I—Randomized controlled trial N = 21 participants older than age 55 who drive more than 1,000 miles/year	Group 1: Participants drove in a Doron Precision Systems driving simulator for 2 hr with films used in the simulator to provide education on proper driving techniques, crash avoidance techniques, and destination driving. Group 2: Participants watched the films taken from the driving simulator that provided education on proper driving techniques, crash avoidance techniques, and destination driving, for 1 hr. Group 3: No intervention Outcomes: <ul style="list-style-type: none"> ■ On-road evaluation of driving skills that included starting/stopping, steering, position in lane, speed, turns, and braking reaction ■ Clinical evaluation of driving skills such as motion/strength, grip, coordination, and proprioception ■ Subjective improvement in driving confidence 	On-road performance for Group 1 was significantly higher compared with both Group 2 and Group 3 driving performance. No significant difference was reported in clinical evaluation of driving skills between any groups.	Small sample size could limit applicability of results; Hawthorne effect, as both Group 1 and Group 2 received more attention than Group 3; assessment of the driving skills might not be a sensitive method to determine changes among the three groups.

Reference: Jacobs, K., Jennings, L., Forman, M., Benjamin, J., DiPanfilo, K., & LaPlante, M. (1997). The use of participation-oriented education in the rehabilitation of driving skills in older adults. *Work, 8*, 281–291.

Janke (1994)	Determine whether California Mature Driver Improvement (MDI), a driving improvement course for older adults, had an effect on crash rates	II—Nonrandomized controlled trial N = 564,444 MDI group: 197,452 participants with an average age of 69 Comparison group: 366,992 participants with an average age of 66	MDI group received information on effects of visual and audio perception, fatigue, medications, and alcohol on driving performance and ways to compensate; updates on rules of the road and equipment; how to plan travel time and select routes for safety and efficiency; and how to make crucial decisions in dangerous, hazardous, and unforeseen situations. The total class duration was approximately 7 hr. Comparison group received no intervention. Outcomes: <ul style="list-style-type: none"> ■ Crash rates before taking the course, after 6 months, 18 months, and 30 months 	Unadjusted comparison between the MDI and the control group indicated that there was no significant difference in terms of accident rates after 6, 18, and 30 months. Although the use of analysis of covariance for adjustment indicates that in one cohort there were fewer crashes in the MDI group and in the other cohort there were more, in the analysis using two-state least-squares regression, completion of the MDI program was associated with more total and fatal injury crashes. Participants in the MDI group received fewer traffic citations in both analyses.	Limitations include lack of randomization to treatment. The ability to show cause in the relationship is limited, because many variables were not controlled for in the analysis.
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Reference: Janke, M. K. (1994). *Mature Driver Improvement Program in California* (Transportation Research Record 1438). [Available from California Department of Motor Vehicles, Research and Development Section, 2415 First Avenue, Sacramento, CA 95818]

Ker et al. (2003)	Determine the effectiveness of postlicense driver education in reducing motor vehicle accidents	I—Systematic review of the randomized controlled (Level I) trials about postlicense driver education N = 28 randomized trials reviewed	The method consisted of systematically selecting the Level I studies using the predefined criteria and analyzing them. Outcomes: <ul style="list-style-type: none"> ■ Traffic offenses ■ Motor vehicle crashes ■ Injuries (fatal and nonfatal) 	The systematic review of randomized controlled trials provides no evidence that postlicense driver education programs are effective in preventing road traffic injuries or crashes. The results indicated a small reduction in the occurrence of traffic offenses with no differences in traffic and injury crashes.	Individual study limitations include inadequate allocation concealment, lack of blinding of outcome assessment, and large losses to follow-up. The results should be interpreted with caution because of heterogeneity in several meta-analyses due to differences in study populations and types of educational programs.
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Reference: Ker, K., Roberts, I., Collier, T., Renton, F., & Bunn, F. (2003). Post-license driver education for the prevention of road traffic crashes. *Cochrane Database of Systematic Reviews, 3*, Article No. CD003734.

(continued)

Table 1. Evidence Table: Person-Related Interventions (continued)

Author/Year	Study Objectives	Level/Design/Participants	Intervention and Outcome Measures	Results	Limitations
Klavora et al. (1995)	Determine the efficacy of the Dynavision apparatus in improving psychomotor abilities and behind-the-wheel (BTW) driving performance after stroke	III—Nonrandomized one-group pretest–posttest N = 10 participants ages 45–80 who had a stroke between 6 and 18 months before the study	Participants received Dynavision apparatus training for 6 weeks, 3 times per week, with each session lasting 20 min. Dynavision was used to measure visual attention, visuomotor coordination, response time, peripheral awareness, eye scanning, concentration, simple cognitive processing, physical endurance, and combinations of these skills. Outcome: ▪ BTW driving performance	Participants performed better on divided-attention and selected-attention tasks after training. Speed of processing did not improve with training. On the BTW assessment, 60% of the participants earned a rating of “safe to resume driving” and/or to receive on-road driving lessons. This percentage of individuals gaining “safe” status after intervention was higher than the previously reported success rate of 24%.	Limitations included the learning effect. Dynavision was used as a training as well as assessment tool. The BTW assessment was reported to be very subjective, resulting in bias. There was no control group.
<p><i>Reference:</i> Klavora, P., Gaskovski, P., Martin, K., Forsyth, R. D., Heslegrave, R. J., Young, M., et al. (1995). The effects of Dynavision rehabilitation on behind-the-wheel driving ability and selected psychomotor abilities of persons after stroke. <i>American Journal of Occupational Therapy</i>, 49, 534–542.</p>					
Llaneras et al. (1998)	Investigate the effectiveness of an ergonomic intervention in producing safe and productive driving in commercial vehicle drivers	I—Randomized controlled trial N = 107, ages 31–76 There were five age cohorts: (1) younger than 50, (2) 50–54, (3) 55–59, (4) 60–64, and (5) 65 and older.	Interventions evaluated included use of the Simulated Prescriptive Auditory Navigational System, which provided prescriptive routing information in the form of auditory commands versus traditional paper-based maps; training on visual search and scanning patterns; comparison of drivers with and without an on-board advanced auditory warning system; and comparison of drivers with an automatic transmission versus drivers with a manual transmission. There also was a control group with no intervention. Outcomes: ▪ Number of missed turns, number of navigational queries, and time to complete the 10-mile (16-km) course ▪ Visual search and mirror checks ▪ Time of detection of malfunction ▪ Manipulation of vehicle during curves, executing turns, speed adjustment, lane position, setting up for turns, overall driving, and braking	Drivers equipped with the Simulated Prescriptive Auditory Navigational System made fewer navigational errors and inquires than drivers who relied on paper-based maps and directions. In addition, drivers exposed to the visual search and scanning training program had better monitoring performance, as measured by visual search and mirror-check scores. Drivers provided with an auditory warning had significantly higher detection rates than drivers without the advanced warning system, and drivers whose trucks were equipped with automatic transmission had better performance during curves than their counterparts equipped with the manual transmission.	Because the study was conducted in a laboratory setting, generalization to on-road vehicle driving environments is limited. Because all the participants in the experimental group were exposed to all four types of intervention, the effect of cointervention might exist, masking the true effect due to a particular intervention.
<p><i>Reference:</i> Llaneras, R. E., Swezey, R. W., Brock, J. F., Rogers, W. C., & Van Cott, H. P. (1998). Enhancing the safe driving performance of older commercial vehicle drivers. <i>International Journal of Industrial Ergonomics</i>, 22, 217–245.</p>					
Mazer et al. (2001)	Examine the use of the UFOV visual attention analyzer in the evaluation and retraining of visual attention skills in clients with stroke	III—Pretest–posttest design N = 6 Mean age: 60; range: 36–82 Participants comprised a large group of 52, from which the 6 were the first to volunteer to participate in training program	Training using the UFOV visual attention analyzer for 20 sessions focusing on 3 modules: (1) processing speed, (2) divided attention, and (3) selective attention. Outcome: ▪ UFOV visual attention analyzer: Visual attention composed of processing speed, divided attention, and selective attention	Significant improvement from pretest in two domains of visual attention—divided attention and selective attention—was reported for all participants. In terms of processing speed, even though there was improvement after posttest compared with pretest, it was not significantly different.	Cointervention: Participants were receiving other forms of intervention. Temporal positive/negative effects of stroke were not taken into consideration. Limitations included learning effects from using the UFOV visual field analyzer for both training and for assessment; small sample size; lack of control group.
<p><i>Reference:</i> Mazer, B. L., Sofer, S., Korner-Bitensky, N., & Gelinas, I. (2001). Use of the UFOV to evaluate and retrain visual attention skills in clients with stroke: A pilot study. <i>American Journal of Occupational Therapy</i>, 55, 552–557.</p>					

Table 1. Evidence Table: Person-Related Interventions (continued)

Author/Year	Study Objectives	Level/Design/Participants	Intervention and Outcome Measures	Results	Limitations
Mazer et al. (2003)	Compare the effectiveness of the UFOV visual attention retraining and conventional visuoperception treatment on the driving performance of clients with stroke	I—Randomized controlled block design N = 97; mean age: 66	Intervention: Training for 20 sessions using the UFOV visual attention analyzer. Control: Conventional computerized visuoperception retraining for 20 sessions Outcomes: <ul style="list-style-type: none"> ■ UFOV: Measures speed of visual processing, divided attention, and selected attention ■ On-road driving evaluation, including driving behaviors, knowledge, and application of driving regulations ■ Visuoperception: Included the Complex Reaction Timer; Motor-Free Visual Perception Test; Single and Double Letter Cancellation Test; Money Road Map Test of Direction Sense; Trail Making Test, Parts A and B; Bells Test; and Charron Test 	No significant difference in visuoperceptual functioning was reported between the experimental and control groups. Although an improvement in driving performance was noted for the intervention group, the difference did not approach statistical significance. There was, however, an almost twofold increase (52.4% vs. 28.6%) in the rate of success on the on-road driving evaluation after UFOV training for participants with right-sided lesions	Cointervention: Participants were receiving other forms of intervention Limitations included learning effects from using the UFOV visual field analyzer for both training and for assessment.
<i>Reference:</i> Mazer, B. L., Sofer, B., Korner-Bitensky, N., Gelinas, I., Hanley, J., & Wood-Dauphinee, S. (2003). Effectiveness of a visual attention retraining program on the driving performance of clients with stroke. <i>Archives of Physical Medicine and Rehabilitation, 84</i> , 541–550.					
Ostrow et al. (1992)	Determine the effectiveness of a joint range-of-motion exercise program on improving driving abilities in older adults.	I—Randomized control trial N = 38 drivers ages 60–85; 22 in the intervention group and 16 in the control group	Intervention group: Upper-body (including neck) range of motion, stretching exercise for 8 weeks at home Control group: Instruction in the car for improving driving skills Outcomes: <ul style="list-style-type: none"> ■ Range-of-motion tests ■ Automobile Driver On-Road Performance Test ■ Behavioral recording log 	Improvement in trunk rotation and shoulder flexibility was reported in the intervention group compared with the control group. Participants in the experimental group improved on handling position and observing compared with the control group. No difference, however, was reported between the groups in terms of amount of driving per week.	Attention bias: The intervention group received more attention than the control group.
<i>Reference:</i> Ostrow, A. C., Shaffron, P., & McPherson, K. (1992). The effects of a joint range-of-motion physical fitness training program on the automobile driving skills of older adults. <i>Journal of Safety Research, 23</i> , 207–219.					
Owsley et al. (2002)	Determine the efficacy and effectiveness of cataract surgery on crashes and driving performance of older adults	II—Prospective cohort study N = 277 patients with cataracts, ages 55–84	Intervention condition: Participants received cataract surgery and intraocular lens implantation Control condition: No cataract surgery Outcome: <ul style="list-style-type: none"> ■ Number of motor vehicle crashes as reported by police 	The intervention group was reported to have half the crash rate (0.47) compared with the control group, after adjusting for race, visual acuity, and contrast sensitivity. The study also reported a reduced number of crashes after cataract surgery, with a number of 4.74 per million miles of travel.	The study considered only police-reported incidents, which may be a limited representation of the total accident crashes that occurred.
<i>Reference:</i> Owsley, C., McGwin, G., Jr., Sloane, M., Wells, J., Stalvey, V. T., & Gauthreaux, S. (2002). Impact of cataract surgery on motor vehicle crash involvement by older adults. <i>JAMA, 7</i> , 841–849.					

(continued)

Table 1. Evidence Table: Person-Related Interventions (continued)

Author/Year	Study Objectives	Level/Design/Participants	Intervention and Outcome Measures	Results	Limitations
Riedel et al. (1998)	Investigate effects of Piracetam on driving performance of elderly individuals without dementia	I—Randomized crossover trial N = 38 drivers between ages 60 and 80; mean age: 66.9	Oral administration of the drug Piracetam twice daily for 4 weeks. Compliance with the protocol was determined by testing urine at Days 2 and 28. Control component: Placebo Outcomes: <ul style="list-style-type: none"> ■ Driving performance: Lateral deviation ■ Balance: Sway and postural stability 	Significant improvement in the intervention treatment period was observed with lower lateral deviation compared with placebo period. Improvement in sway was observed in participants after 4 weeks on Piracetam compared with the control period. No adverse effects were observed with the use of the drug.	Driving performance was not comprehensive; period of treatment with Piracetam may not have been long enough to determine the full effect of the drug.
<p><i>Reference:</i> Riedel, W. J., Peters, M. L., Van Boxtel, M. P. J., & O'Hanlon, J. F. (1998). The influence of piracetam on actual driving behaviour of elderly subjects. <i>Human Psychopharmacology</i>, 13, 108–114.</p>					
Roenker et al. (2003)	Determine effectiveness of the speed-of-processing training in UFOV on driving performance	I—Randomized controlled trial N = 104 licensed drivers Mean age: 69; range: 48–94	Group 1: Control group with no intervention (n = 27) Group 2: Speed-of-processing training with individual UFOV on a computer screen (n = 51) Group 3: Simulator training, focusing on crash avoidance, managing intersections, and scanning (n = 26) Outcome: <ul style="list-style-type: none"> ■ Open-road driving evaluation. All assessments were completed pre- and postintervention and 18 months after intervention 	Although the data indicated that improvement in driving skill is specific to type of training, improvement was observed in all 3 groups, with Group 3 improving the most compared with the control and speed-of-processing training groups. Some gains disappeared at 18 months, but retention of the driving skills acquired during training was maintained in the speed-of-processing training group after 18 months.	Limitations included lack of assessment of cognitive function.
<p><i>Reference:</i> Roenker, D. L., Cissell, G. L., Ball, K. K., Wadley, V. G., & Edwards, J. D. (2003). Speed-of-processing and driving simulator training result in improved driving performance. <i>Human Factors</i>, 45, 218–233.</p>					
Schmidt et al. (1991)	Investigate the effects of Piracetam on the driving performance of drivers with reduced reaction capacity	I—Randomized controlled trial N = 96 participants ages 48–76 49 intervention; 47 control	Intervention group: Participants were given 4.8 g/day of Piracetem for 6 weeks Control group: Placebo Outcomes: <ul style="list-style-type: none"> ■ Driving test ■ Emotionality inventory (EMI–B) 	A significant improvement after 6 weeks of intervention was reported in the intervention group in all areas of driving performance.	Long-term benefits/adverse effects of the drug were not reported in the study, which might be needed to determine the risk–benefit ratio.
<p><i>Reference:</i> Schmidt, U., Brendemuhl, D., Engels, K., Schenk, N., & Ludemann, E. (1991). Piracetam in elderly motorists. <i>Pharmacopsychiatry</i>, 24, 121–126.</p>					
Stalvey & Owsley (2003)	Evaluate the efficacy of Knowledge Enhances Your Safety in preventing crashes while driving in older individuals with visual limitations.	I—Randomized controlled trial N = 365 high-risk drivers older than age 60 with a visual acuity and/or processing deficit, high level of driving exposure, and a history of crash involvement Mean age: 74; range: 60–91	Group 1: Eye examination with discussion about impact of visual limitations of driving (n = 171) Group 2: Usual care plus educational intervention (2 sessions for 3 hr total; n = 194) Outcome: <ul style="list-style-type: none"> ■ The Driver Perceptions and Practices Questionnaire, which assessed self-perception of vision impairment and its impact on driving; perceived threat of crash involvement; barriers to the performance of self-regulatory practices; level of readiness to adopt new behavior; and regulatory self-efficacy 	Perception for level of vision impairment and understanding about its impact on driving was higher in intervention group compared with control group. Perceived benefits of self-regulation and readiness to change was significantly higher in the intervention group compared with the control group. No significant difference was reported between groups in terms of perceived threat of crash involvement, perceived barriers to self-regulation, and perceived regulatory self-efficacy.	Outcomes were self-reported.
<p><i>Reference:</i> Stalvey, B. T., & Owsley, C. (2003). The development and efficacy of a theory-based educational curriculum to promote self-regulation among high-risk older drivers. <i>Health Promotion Practice</i>, 4, 109–119.</p>					

Table 1. Evidence Table: Person-Related Interventions (continued)

Author/Year	Study Objectives	Level/Design/Participants	Intervention and Outcome Measures	Results	Limitations
Vollrath et al. (2002)	Determine whether the presence of passengers when driving in a vehicle increases the risk of a collision with another vehicle	II—Nonrandomized population-based cohort design N = 112,847 crashes to drivers older than age 18. Excluded single-vehicle crashes and those in which one involved was not a private car.	No intervention; observational study Outcomes: <ul style="list-style-type: none"> ■ Accidents reported by police ■ Demographics of drivers ■ Accident situational conditions (e.g., time of accident, weather conditions.) ■ Description of accidents (e.g., cause, nature.) 	The presence of passengers was a “protection” against accident risks for all age groups. This protection was reported to be most effective for drivers in the 50+ age group, followed by drivers ages 25–49, and was minimally effective for drivers ages 18–24. From the situational variables, visual conditions and traffic density influenced the passenger effect, whereas type of road and day of week did not show a significant influence.	The study did not consider the physical/mental condition of drivers, which needs to be controlled to examine complete effect of presence of passenger on accident risks.
<i>Reference:</i> Vollrath, M., Meilinger, T., & Kruger, H. (2002). How the presence of passengers influences the risk of a collision with another vehicle. <i>Accident Analysis and Prevention</i> , 34, 649–654.					
Yee & Melichar (1992)	Develop and evaluate the effectiveness of a 3-level multiphasic integrated assessment and intervention strategy	II—Nonrandomized controlled trial N = 254 (174 intervention, 80 control) Mean age: 64; age range: 43–89	Intervention group (n = 174) completed the Older Driver Self-Assessment Inventory, which included three steps: <ol style="list-style-type: none"> 1. Identification of drivers potentially at risk through screening 2. Educational intervention improving knowledge and skills about driving 3. Driving simulation to remediate driving skills deficits Control group (n = 80) Outcome: <ul style="list-style-type: none"> ■ Attitudes Assessment Test (AAT) 18 questions that examine attitudes regarding driving and driver reeducation ■ Knowledge Assessment Test—31 questions included those regarding information on general driving, rules of the road, response to driving, and aging and driving conditions. 	No differences in subjective opinion about perceived task difficulty were reported. There was no difference in attitudes between the pre- and posttest scores of the treatment and control groups. A pre-post test change for knowledge items on the KAT was noted only for participants who had the assessment and education components. There was a difference, however, in scores, depending on the location of instruction (Texas and California).	The use of multiple sites, types of participants, and multiple levels of intervention (with differential dropout rates of each) adds to the intervention bias. Because of the lack of a follow-up period, the long-term benefits of the Older Driver Self-Assessment Inventory in identification and remediation of older drivers in prevention of crashes are unknown.
<i>Reference:</i> Yee, D., & Melichar, J. F. (1992). <i>Accident prevention through driving skills assessment and interventions for older drivers: ApProgramme</i> (EDRS 371–127; CE 066–474). San Francisco: San Francisco State University.					

and the study did not evaluate impact on driving performance.

Insufficient evidence exists from a Level I study (Jacobs et al., 1997) that older adults receiving training in a driving simulator had better on-road performance than those watching driver education videos. This study also found no relationship between performance on the clinical evaluation of driving skills (e.g., coordination, braking time, traffic symbol knowledge) and on-road driving performance. The results of this study were limited by small sample size and potential Hawthorne effect.

Evidence conflicts regarding the role of passengers from two Level II studies on the effect of passengers driving with older adults. Although one Level II study (Vollrath, Meilinger, & Kruger, 2002) found a protective effect for

passengers driving with those older than age 50, Hing, Stamatiadis, and Aultman-Hall (2003) found that drivers with two or more passengers were more likely to be involved in crashes on roads with curves and grades. In this study, however, passengers were protective for crashes when driving on roads with curves and grades at night. The results indicated that passengers may have provided guidance at night but distraction under complex driving conditions during the day.

Three studies examined the effect of medical interventions on driving performance. In a Level II cohort study, those receiving cataract surgery were reported to have half the crash rate of those electing not to have the surgery when controlling for race, visual acuity, and contrast sensitivity (Owsley et al., 2002). It was also noted that study participants receiving

surgical treatments for cataracts continued to self-limit their driving after the surgery. Conclusive evidence from two Level I studies (Reidel, Peters, Van Boxtel, & O'Hanlon, 1998; Schmidt, Brendemuhl, Engles, Schenk, & Ludemann, 1991) shows that taking piracetem (Nootripil, a cognitive enhancer) for 4 to 6 weeks can improve driving performance and reduce postural sway in older adult participants.

Limitations of the studies incorporated into the review may include lack of randomization, lack of control group, small sample size, and use of self-report measures. In several studies, a learning effect may have taken place because the use of an assessment measure as an intervention may limit the intervention's true effect. In several Level II studies based on large databases, the authors were not able to control for factors that may have affected the studies' results. In one Level II study, the use of police-reported crashes as an outcome may have provided a partial picture of total crashes. Also, it is difficult to understand the impact of individual interventions in studies incorporating more than one intervention at a time.

Discussion and Implications for Practice

Community mobility is essential to personal autonomy and, thus, it is an ability that older adults are motivated to maintain. The studies summarized in the narrative provide clear evidence that clinical and community-based occupational therapists and occupational therapy assistants must think beyond driving and mobility rehabilitation as purely recommending and training in the use of adaptive equipment.

Instead, education and training of practicing therapists and of occupational therapy students must include the research showing that impaired skills in vision, cognition, and motor function may be addressed by specific intervention programs, including client educational programs that aim to develop client self-awareness of driving skills. These intervention programs may have a positive impact on driving behaviors. For example, medical and pharmaceutical treatments are available to address some visual, cognitive, and motor problems. By keeping current on new therapies and communicating with other health care providers, occupational therapists and occupational therapy assistants may help resolve untreated problems. Likewise, occupational therapists and occupational therapy assistants need to educate clients on the relationship between medical problems and driving.

Few reliable rehabilitation methods have been designed to target driving-related deficits. The interventions presented in the vision, cognitive, and motor domains involve rehabilitating the underlying skills that support performance on the driving task. At present, occupational therapists and occupational therapy assistants may use pencil-and-paper or com-

puter tasks, puzzles, and related activities when considering interventions for visual and cognitive deficits. However, conventional techniques are limited in several respects. First, the training environment currently used by occupational therapists and occupational therapy assistants often consists of only a standard-sized sheet of paper or computer monitor. The driving environment, however, encompasses a far broader field across multiple planes in which eye scanning and visual attention must occur over a greater range, often involving head movement, which is what the Dynavision training encompasses. Driving also imposes a high demand on peripheral vision, which affords a viewer with a general awareness of the surroundings a skill addressed by training on both the UFOV Analyzer and Dynavision.

These studies lead the way for occupational therapists and occupational therapy assistants to use a variety of training techniques. Because the brain performs many functions, the best approach may be to engage older adults in multiple training activities that enlist the functions of all areas of the brain. Various stimuli can excite different brain functions, all necessary for safe driving. Occupational therapists and occupational therapy assistants should explore experiential training with sensory (vision and proprioception) and cognitive (attention, memory, and reaction time) elements. A more global training approach may reactivate areas that have slowed or weakened and contribute to behavioral and cognitive improvements for safer driving.

Results from research (Hunt, Morris, Edwards, & Wilson, 1993) have revealed that most individuals fail to recognize their decline in driving competence and adjust to lower levels of visual acuity, reduced reaction time, and reduced peripheral vision and cognitive function. Interventions that could develop insight into clients' deficits regarding driving (Stalvey & Owsley, 2003) may be most valuable. For example, occupational therapy clients may have visual impairments but still be within the legal range of acuity to drive. Occupational therapists and occupational therapy assistants may help these clients maintain independent community mobility by educating them on driving conditions that may challenge their visual capabilities. Discussing alternative routes (avoiding left turns or changing lanes) and better times of the day to drive (avoiding sun glare and dusk or dawn) may extend the period of safe driving. These are discussions that any practicing occupational therapist or occupational therapy assistant should have with older clients. It is not a conversation reserved for those specializing in driving rehabilitation. The potential exists for occupational therapists and clients to struggle with vision and cognitive interventions if it appears to the client that these activities have nothing to do with driving. For example, a computerized intervention such as UFOV training that addresses

visual attention may not seem to relate to a client's perception of skills required to drive. Making the association known to the client is the first step in obtaining commitment to an intervention program. Finally, occupational therapists and occupational therapy assistants and older clients may wrestle with the disparity between real competence and perceived competence on driving performance. For example, older drivers may believe they are safe drivers because they have driven for many years, drive slowly, and have had no major driving incidents when, in fact, an in-car on-the-road driving assessment demonstrates that they have difficulty maintaining a vehicle in the driving lane and that other drivers take evasive actions to avoid crashes. Stalvey and Owsley (2003) added evidence to the importance of developing client self-awareness when counseling older drivers on cessation or limiting driving and being committed to learning and accepting intervention strategies.

Ker et al. (2003) and Janke (1994) provided evidence that classroom instruction may give older drivers a false sense of their ability to drive, especially when visual and cognitive factors remain unexplored. Because clients and third-party payers pay for these educational sessions, occupational therapists and occupational therapy assistants must be aware that the evidence does not strongly support this type of intervention. Learning and retaining information and skills may best be accomplished when the learning process is actual engagement in that activity rather than lectures and reading of information. This engagement in the activity to be learned is at the heart of occupational therapy practice. In-class-only instruction may be unsuccessful because the learner is passive. This theory deserves further exploration. In addition, occupational therapists know that underlying skill assessment is essential to understanding learning ability. For example, in educational programs there may be no knowledge of the participants' cognitive skills or visual skills that could affect learning. When prerequisite skills are not assessed, it is not certain whether clients have medical or aging conditions that impair learning and actual driving behaviors.

Clearly, this is an exciting time for occupational therapy. New research is providing expanded methods of interventions that could be used to assist clients in their pursuit of maintaining community mobility. By using this new research, occupational therapists and occupational therapy assistants can evaluate their effectiveness and come up with new research ideas to be tested. By implementing these interventions, they begin to contribute to future research findings, thus adding to the body of knowledge that will help clients maintain mobility.

According to the *Occupational Therapy Practice Framework* (AOTA, 2002), client follow-up is critical for all intervention programs and is part of the occupational therapy

practice process. New behaviors that are not constantly reinforced may revert to previous unproductive habits. Therefore, any interventions to improve driving performance require timely follow-up. Finally, and most important, occupational therapists and occupational therapy assistants must always evaluate and use clinical reasoning to determine whether a particular intervention is appropriate for a client. ▲

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