



AOTA Critically Appraised Topics and Papers Series
**Driving and Community Mobility
for Older Adults**

**A product of the American Occupational Therapy Association's
Evidence-Based Literature Review Project*

CRITICALLY APPRAISED TOPIC (CAT)

Focused Question #4

What is the evidence for the effect of modifications of the infrastructure of the physical environment (e.g., roadways, signage, and lighting) on the driving ability, performance, and safety of the older adult?

Clinical Scenario:

Increasingly, drivers using roadways in the United States are age 65 and older. Elderly drivers show an increased likelihood of being involved in automobile accidents along with an increase risk of injury when involved in crashes. These increased risks are most likely associated with age-related declines in visual, cognitive, and psychomotor abilities related to driving and with the increased frailty of older drivers. Often occupational therapists and occupational therapy assistants intervene with individuals who experience driving-related problems that accompany aging or arise from medical conditions that make driving more dangerous. Occupational therapists and occupational therapy assistants may find that older drivers consider driving to be essential to their independence and quality of life, especially when acceptable alternatives are not available. Thus, occupational therapy's focus on maximizing occupational performance and community participation must include evaluation and intervention for driving-related issues.

Summary of Key Findings:

Summary of Levels I, II, and III

Studies published after 1999 and not included in the *Highway Design Handbook for Older Drivers and Pedestrians* (Staplin et al., 2001) addressed (1) the size and type of fonts used for traffic signs, (2) the color of signs, (3) types of coatings to improve legibility of signs and pavement markings, (4) the ability of older drivers to detect signs and acquire familiar and unfamiliar sign messages, and (5) pedestrian safety.

FONT SIZE AND TYPE FOR ROADWAY SIGNS:

The results of three Level I randomized mixed factor studies (Carlson et al., 2001; Chrysler, Carlson, & Hawkins, 2002; Guerrier & Fu, 2002, Test 2A) indicate that there is limited benefit to using the Clearview font as opposed to Highway Series C and Series D because there may be an advantage for older drivers' acquisition of traffic sign messages as well as some legibility advantage during nighttime driving.

COLOR OF SIGNS: The effects of sign color on legibility distance at night were examined by Chrysler et al. (2002) in a randomized mixed factor design study. Older drivers performed more poorly when reading orange signs typically used in construction zones signs that are not orange.

TYPES OF COATINGS TO IMPROVE LEGIBILITY OF SIGNS AND PAVEMENT MARKINGS:

One Level I randomized mixed factor design study (Chrysler et al., 2002) and a Level III pre-post test study (Guerrier & Fu, 2002, Test 2B) found no functional difference in legibility among various types of retroreflective sheeting. The results of Guerrier and Fu (2002, Test 2B) do indicate, however, that lane markings that were in good repair were more visible than those in poor condition. This suggests that it is important that lane marker treatments be well maintained if they are to be clearly visible to drivers of all ages, including older drivers with age-related vision changes.

ABILITY OF OLDER DRIVERS TO DETECT SIGNS AND ACQUIRE FAMILIAR AND UNFAMILIAR SIGN MESSAGES: Static, high-clutter driving scenes, projected in a laboratory environment, were associated with poor search performance when determining if traffic signs were present in the test environment (Ho, Scialfa, Caird, & Graw, 2001). Older adults were slower and less accurate than younger drivers and required more fixations to acquire the traffic signs during the laboratory simulation. It is unclear if the findings would be similar should these experiments be extended to dynamic environments where time, space, and vehicle control constraints might influence outcomes.

Based on laboratory experiments there is evidence that older drivers may be able to recognize familiar road signs even though their acuity may have declined with age (Kline, Buck, Sell, Bolan, & Dewar, 1999). Legibility thresholds were lower for older versus younger participants and for familiar (standard) signs versus unfamiliar signs. This result suggests that older drivers may utilize an age-related compensatory ability to acquire sign messages.

PEDESTRIAN SAFETY:

A Level I study (Carmeli, Coleman, Omar, & Brown-Cross, 2000) indicated that older adults require significantly more time to walk “as fast as possible” outdoors than indoors. This finding is of importance at intersections. The authors report that this finding may be due to environmental factors such as uneven terrain and variability in outdoor temperature, lighting, wind, and humidity.

Summary of Levels IV and V

Staplin et al. (2001) *Highway Design Handbook for Older Drivers and Pedestrians*
This handbook provides recommendations for roadway design that consider the demonstrated performance changes of normally aging drivers. The handbook does not constitute new standards of required practice, but rather provides recommendations for enhancing the safety and ease of use of roadways by older drivers. Although the *Highway Design Handbook* incorporates an extensive review of the literature, the studies included were not classified with respect to level of evidence, and a critical review of individual studies was not included. This makes it difficult for the reader to know which research and recommendations should be more heavily weighted.

INTERSECTIONS

- **SKEW:** Intersecting roadways should meet at a 90° angle
 - Optimal conditions to detect and make judgments about on-coming vehicles.
 - Increased maneuvering time for navigation of the intersection. This is especially important because of the decline in head and neck mobility and decrease in peripheral field that accompanies aging.

DESIGN FOR TURNS:

- Wider turning lanes can facilitate better positioning of the vehicle within the lane in preparation for turning.
 - Wider receiving lanes minimize the chances of encroachment on other lanes (i.e., swinging too wide to lengthen the turning radius and minimize rotation of the steering wheel).
 - Wider lanes allow older drivers more opportunity to remain within the boundaries of their assigned lanes during turning maneuvers secondary to the diminished ability to share attention and to turn the steering wheel sharply enough, given their traveling speed, to negotiate the turn. For left-turns, raised channelization, treated with retroreflective markings to increase visibility, provides additional cuing to older drivers who experience the age-related decline in visual acuity and contrast sensitivity that impairs their abilities to detect/recognize pavement lane markings.
 - Retroreflective pavement markings, used to indicate the turning path, provide additional cuing to minimize encroachment on other lanes.
 - Wider lanes, raised channelization, and retroreflective pavement markings are especially important for high-traffic areas or where there is a demonstrated crash problem.
 - Right-turn movements are facilitated by an adequate curb radius that minimizes the chance of hitting the curb. The size of the curb radius affects the size of vehicle that can turn at the intersections. As older drivers tend to drive larger cars, the curve radius needs to be adequate not only so the car avoids hitting the curb, but also so the driver does not encroach on other lanes of traffic while maneuvering around the corner.
 - Lane-use devices should provide enough preview time so that the older driver is less prone to erratic maneuvers such as lane weaving that result from late detection.
- Lane-use control signs for lane assignment on intersection approaches should be consistently positioned overhead on signal mast arms or span wire where they are more easily viewed. Pavement markings indicating lane-use should be positioned in advance of the signalized intersection.

DESIGN FOR ROUNDABOUTS:

- Modern roundabouts are useful to address the problems older drivers may have judging speeds and gaps to maneuver through turns.

- Roundabouts eliminate left turns, facilitate traffic flow, provide a large curb radius to improve maneuverability, and reduce speed of vehicles entering the circle, thereby simplifying the decision-making process for the older driver.

SIGHT-DISTANCE REQUIREMENTS:

- An unobstructed view of the entire intersection and sufficient lengths of roadway give the older driver more time to make decisions about whether to proceed, slow, or stop to avoid a collision with potentially conflicting vehicles.
- Turning maneuvers require longer sight-distance requirements for the older driver since it may take significantly longer to perceive that a vehicle is moving closer at a constant speed before making a decision about whether to proceed with the turn.
- Sight distance can be increased for left turns by a positive offset of opposing left-turn lanes. This provides a margin of safety for older drivers who do not position themselves within the intersection before initiating a left turn.

SIGNAGE AND MARKINGS:

Lane Delineations:

- Signs indicating DIVIDED HIGHWAY CROSSING, WRONG WAY, DO NOT ENTER, KEEP RIGHT, and ONE WAY should be oversized and treated with retroreflective sheeting to increase their conspicuity and legibility by older drivers.
- The use of retroreflective pavement markings indicating the turn path and retroreflective wrong-way arrows in the through lanes reduces the likelihood of entering the wrong lane.
- Retroreflective treatment applied to median noses increases their visibility and provides the older driver with more cues to assist their understanding of the intersection design.

Edgelines, curbs, medians, obstacles:

- Marking curbs, medians, and obstacles on their vertical face and a portion of the top surface decreases the likelihood of collision with the raised surfaces by making them more conspicuous to older drivers who may have decreased contrast sensitivity, reduced useful field of vision, increased decision time, and slower vehicle control.

Street-name signs:

- Street-name signs must be detected and legible if they are to provide guidance to drivers.
- Detection is improved by placement of the sign and contrast of the sign with the surrounding background. For example, at major intersections, there should be overhead-mounted street-name signs, which are more likely to be seen before those located on either side of the roadway.
- Redundant signage in the form of advance street-name signs, black lettering on a yellow sign panel, should be placed upstream of the intersection at the midblock location.

- Detection is less of a problem on streets with lower volumes of traffic and where traffic speeds do not exceed 25 mph. In these cases post-mounted street-name signs may be used, but a minimum letter height of 6" should be used to accommodate the reduced visual acuity associated with increasing age.
- Legibility of signs is improved with larger lettering of signs, more luminance (brightness) of the characters, and positive contrast between the letters and the sign.
- Retroreflective treatments that increase sign conspicuity and legibility at the widest available observation angles accommodate the older drivers who experience age-related visual acuity loss.
- Using mixed-case fonts with more character openness and smaller intercharacter spacing, such as the Clearview font, improves legibility distance. Additionally, using fonts 30% larger than standard highway character size allows older drivers to read the signs far enough in advance of the intersection to make decisions about negotiating the intersection. If necessary, borders around standard panel size signs can be eliminated to increase legibility.

One-way/wrong-way signing:

- Older drivers who have difficulty abstracting information and making quick decisions often require more effective and more conspicuous signs to alert them to wrong-way movements.
- Accommodation for age differences in glare sensitivity and restricted peripheral vision should be provided through multiple or advance signs as well as changes in size, luminance, and placement.
- Wider intersections, especially divided roadways, require additional ONE WAY signs on the divider median to increase conspicuity. Additionally, DO NOT ENTER and WRONG WAY signs may be needed. Retroreflective treatments increase visibility of signs, and high contrast provides better legibility.

Stop and yield-controlled intersection signing:

- Age-related changes in vision and attention necessitate improved stop control and yield control at nonsignalized intersections.
- At intersections where greater visibility or emphasis is needed, the STOP sign size (standard 30") should be increased to 36" while YIELD sign size (standard 36") should be increased to 48".
- Background retroreflective levels for STOP and YIELD signs should be sufficient to provide conspicuity and timely detection.
- Rumble strips or transverse pavement stripping upstream of the stop-controlled intersection serve as an alert when sight restrictions or high approach speeds are present. Additionally, a STOP AHEAD sign can be installed to provide a minimum preview distance and ensure adequate time to stop.

TRAFFIC CONTROL SIGNALS:

Traffic Signals:

- Older drivers need increased signal luminance (brightness) and contrast to perceive traffic signals. Performance of the older driver may also suffer with disabling glare.

- A wide viewing angle of the signal helps to increase the signal strength, since information is accessible over longer intervals.
- A large, black surround behind the signal (backplate) provides improved contrast, especially where there is potential for sun glare problems.
- Intervals between phases should be based on perception-reaction time, with a longer yellow interval to accommodate older drivers.

For left-turn movements:

- Protected-only operations, ideally leading protected left turns, are recommended to reduce the crash rates of the elderly at signalized intersections.
- Overhead LEFT TURN YIELD ON GREEN signs alert drivers to the signal, and redundant signs indicating LEFT TURN AT SIGNAL, positioned at an adequate preview distance before the intersection, allow the driver to position the vehicle in the left turn lane.
- Since older drivers often have difficulty integrating time and distance information to estimate approaching vehicle speeds, it is important that the left turn signal be long enough to provide adequate decision making (go/no go) time for the older driver.
- The green arrow signal light should terminate into a yellow before going to a steady red to allow a buffer for slower moving vehicles to complete the turn across on-coming traffic lanes before that traffic begins to enter the intersection.

For right-turn movements:

- Right-turn-on-red should be prohibited at intersections where the skew of the intersecting roadways limits sight distance. This is particularly important for older drivers whose restricted head and neck motion place them at a disadvantage for perceiving approaching conflicting traffic.
- When right turns are not permitted, a steady circular red indicator should be used along with a NO TURN ON RED sign positioned overhead where it is most conspicuous.
- When right turns are permitted, the stop line for the right turn lane should be offset 6–10 feet forward of the other lanes to provide better sight distance. Additionally, TURNING TRAFFIC MUST YIELD TO PEDESTRIANS signs should be used at intersections where turning vehicles conflict with pedestrians who are using the crosswalk.

FIXED LIGHTING:

- Fixed lighting on a roadway increases the visibility of the roadway and the immediate surrounding area. Roadway lighting permits drivers to maneuver more safely and efficiently, particularly where there are shifting lane alignments, turn-only lane assignments, pavement-width transitions that force a path following adjustment, or at intersections.
- Maintenance of lighting installations should include cleaning lamp lenses regularly and replacing the lenses when their output falls below 80% of peak performance.

INTERCHANGES

EXITS FROM HIGHWAYS:

Exit Signing:

- Exit signs must be detectable and legible to be effective. Redundant overhead placement of exit signs upstream from the exit ramp facilitates detection. Retroreflective treatments increase sign conspicuity and legibility to accommodate the drivers with age-related visual acuity loss.
- As with overhead street signs, the use of mixed-case fonts with more character openness and smaller intercharacter spacing (e.g., Clearview) improves legibility distance. Mixed-case fonts such as Clearview should also be used for ground-mounted signs to increase reading distance of all highway destination signs.
- The use of larger letters aids the older driver in reading unfamiliar words or word combinations. To minimize confusion, arrow shafts appearing on upstream diagrammatic guide signs should match the number of lanes on the roadway at the sign's location.

Ramp gore delineation:

- *Gore* is defined as the area immediately beyond where two roadways split, bounded by the edges of those roadways.
- When the exit is non-illuminated or partially illuminated, the gore should be marked with partially retroreflective flexible posts and partially retroreflective pavement markers to assist drivers in identifying the boundaries of the exit lane. Especially at night when drivers cannot rely on a direct view of the ramp, these markers outline the location of the gore.
- For older drivers with limited night vision, the partially retroreflective flexible posts are more effective than other types of markers.

Acceleration/deceleration lane design:

- Diminished capabilities to accurately and reliably integrate speed and perceived distance information for moving vehicles, reduced neck/trunk flexibility, and age-related changes in attention-sharing capabilities place the older driver at higher risk for collisions on acceleration and deceleration lanes. This is particularly problematic when traffic volume is high.
- To allow the older driver the greatest advantage for successfully negotiating entrance onto a highway, it is advisable that acceleration lane lengths be increased and that a parallel design for entrance ramps be used to allow enough time for gap search and decision-making processes.
- For exit ramps it is advisable to locate the ramp exits downstream from sight-restricting vertical or horizontal curvature of the main road.

TRAFFIC CONTROL DEVICES FOR RESTRICTED OR PROHIBITED MOVEMENTS ON FREEWAYS, EXPRESSWAYS, AND RAMPS:

- Age-related diminished capabilities (particularly selective attention, divided attention, visual acuity, and contrast sensitivity) contribute to wrong-way movements on highways just as they do on other roadways.
- Preventive measures to reduce the frequency of wrong-way movements by older drivers include modification of ramp and roadway design, signing and pavement markers, and use of warning and detection devices and vehicle arresting systems.
- For example, overhead land control signal indicators for prohibited movements (red X) provide conspicuous warning. Guide sign panels marking FREEWAY ENTRANCE provide positive guidance.
- Additionally, median separators with retroreflective markings reduce the chance of crossover where entrance and exit ramps are adjacent to each other.

FIXED LIGHTING:

- The effects of aging on the visual system compound the effects of darkness and increase the risk of collision for older drivers, particularly around interchange areas.
- Most notably the declines in visual acuity, contrast sensitivity, glare recovery, and peripheral vision make night driving more difficult for older drivers.
- Increased illumination at interchanges significantly reduces vehicle crashes. Complete interchange lighting is preferred but may not always be feasible; instead, a partial interchange lighting system may be used.

ROADWAY CURVATURE AND PASSING ZONES

PAVEMENT MARKINGS:

- Pavement markings and delineation devices provide information about road alignment.
- Under daylight conditions the markings and delineations should have a high enough effective luminance contrast to the roadway surface to be easily distinguished by older drivers who may have diminished contrast sensitivity.
- During nighttime driving the use of thick, slightly raised, retroreflective stripes is recommended as they reflect more light back to the driver under both dry and wet pavement conditions.
- Raised pavement markers applied along the centerline are recommended for sharper curves. Additionally, the use of chevron alignment signs and roadside post-mounted delineation devices provide more information about road curvature.
- For the older driver with lanekeeping difficulties and diminished motor abilities, these pavement markings and delineations can provide needed guidance.

ADVANCED SIGNING FOR SIGHT-RESTRICTED LOCATIONS:

- Older drivers have often developed strong expectations about where and when they will encounter road hazards. With well-established expectations and slower reaction time to unexpected information, the older driver is often slower to override an initially incorrect response with a correct response to the hazard.
- When expectations are paired with physical changes, the older driver may have diminished ability to execute rapid vehicle control when an emergency maneuver is required.
- Signing that forewarns drivers of potential hazards can decrease the risk of collision. For example, warning signals paired with yellow placards with PREPARE TO STOP in black clue drivers into a signalized intersection that may be obscured by vertical or horizontal curvature of the road.

PASSING ZONES AND PASSING/ OVERTAKING LANES ON TWO-WAY HIGHWAYS:

- The most conservative passing sight distance requirement should be used to accommodate age-related difficulties in judging gaps, longer decision-making, and protracted reaction times exhibited by older drivers.
- Retroreflective centerline pavement markings supplemented with yellow NO PASSING ZONE pennants at the beginning of no passing zones are recommended. When passing/overtaking lanes (in each direction) are included in two-way highway design, they should be placed at sufficiently long intervals to avoid mid-lane collisions.

CONSTRUCTION ZONES

LANE CLOSURE/LANE TRANSITION PRACTICES:

- Advanced warning of lane closure, changes in direction of the lateral shift in the travel path, and lane drop must be provided in sufficient time for drivers to make timely decisions, as older adults benefit from longer exposure to stimuli.
- Advanced warning is important for older drivers who require increased time to prepare and initiate a safe merging maneuver rather than an erratic vehicle movement.
- For a work zone on high-speed roadways and divided highways, a supplemental, portable changeable message sign displaying a one-phrase message (such as LEFT LANE CLOSED) should be located upstream of the lane closure. At the taper for each lane closure, a flashing arrow panel indicating lane closure is recommended.
- Abbreviations can be misunderstood.
- Redundant static signing with high retroreflectance is recommended throughout the entire time period of the lane closure.
- Driving speeds should be reduced in work zones, and channelization (barriers in transition zones and positive separation) between opposing two-lane traffic on all roadways except residential should be used.

- To accommodate the needs of older drivers, channelizing devices include traffic cones with bands of retroreflective material for nighttime operation, tubular markers with a band of retroreflective material, striped vertical panels, chevron panels, and drums with high-brightness sheeting for orange and white retroreflective stripes.

PORTABLE CHANGEABLE MESSAGE SIGNING:

- Changeable message signs are effective only if they are conspicuous, legible, and placed where there is least likelihood of being blocked from a motorist’s view. The exposure time, or available viewing time, also determines whether the message is acquired by the driver.
- The needs of the older driver should dictate character and letter legibility, legibility distance, and placement. Character and message legibility of changeable message signs should reflect the same considerations as for static signs (i.e., contrast, luminance, color and contrast orientation, font, letter height, letter width, case, and stroke width).

HIGHWAY-RAIL GRADE CROSSINGS

- Older drivers with decreased contrast sensitivity and the need for increased levels of light for night driving benefit from increased detectability and conspicuity of railroad crossing signing and added illumination of passive crossings.
- Detectability and conspicuity can be increased by use of crossbuck posts with white, high-brightness, retroreflective sheeting; advanced retroreflective pavement markings; post-mounted delineators with high-performance retroreflective sheeting; and luminaries.

PEDESTRIANS

AGE-RELATED CHANGES

- Age-related changes that may make it difficult for older adults to navigate intersections include decreased contrast sensitivity and visual acuity, decreased peripheral vision and “useful field of view,” decreased ability to judge safe gaps in traffic, and slowed walking speed.
- Age-related decline in physical strength, joint flexibility, agility, balance, coordination, and endurance may contribute to slower walking speeds and difficulty negotiating curbs.
- Other behaviors of older pedestrians include a greater likelihood to delay before crossing, spending more time at the curb, taking longer to cross the road, and making more head movements before and during crossing.

CRASH TYPES

Crash types that predominantly involve older pedestrians include:

- vehicle turn/merge,
- intersection dash where a pedestrian appears suddenly in the street in front of an oncoming vehicle at an intersection

- bus-stop related in which a pedestrian steps out in front of a stopped bus and is struck by a vehicle
- stopped-vehicle-related, in which the pedestrian walks in front of the stopped vehicle and into the path of another vehicle.

POSSIBLE PREVENTION MEASURES

Measures that have been shown to have promise in improving the safety of older pedestrians include

- Use of regulatory signs such as YIELD TO PEDESTRIANS WHEN TURNING In some studies, these signs have been effective in reducing the conflicts between turning vehicles that could potentially lead to crashes
- Exclusive timing or leading pedestrian interval (LPI), in which traffic signals stop motor vehicle traffic in all directions simultaneously for a phase each cycle when pedestrians are allowed to cross the street. Exclusive timing is intended to eliminate turning traffic or other movements that conflict with pedestrians crossing the street.

Contributions of Qualitative Studies:

NR

NR = Not reported.

Bottom Line for Occupational Therapy Practice:

With increasing age, the ability to safely drive an automobile is influenced by changes in perceptual, cognitive, and psychomotor performance. With the changing demographics of our driving population (i.e., more older drivers), the increase in traffic volume and congestion, it is imperative that roadway systems be designed to address the demonstrated performance changes of normally aging drivers. The design of driving environments, based on current state-of-the-art knowledge of the needs of normally aging seniors, can significantly enhance the safety and ease of using roadway systems for the older driver.

Review Process

Procedures for the selection and appraisal of articles

Inclusion Criteria:

- Peer-reviewed journals from 1980–2004
- Evidence-based reviews (e.g., Cochrane Database of Systematic Reviews)
- Published reports (e.g., Transportation Research Board) from 1999 to 2004
- Information prior to 1999 was taken from the *Highway Design Handbook for Older Drivers and Pedestrians* (2001).

Criteria:

- Level IV and Level V studies
- Dissertations
- Conference Proceedings

Search Strategy

Categories	Key Search Terms
Patient/Client Population	Elderly, Older Driver, Aging
Intervention	Roads, Street, Highway Markings, Traffic Signals, Signage, Glare Effects, Pavements, Illumination, Traffic, Pedestrians, Visual Environments, Highway Safety, Traffic Safety
Comparison	Filter developed by McMaster; research study terms
Outcomes	Not included in search

Databases and Sites Searched

TRIS Online, Ergonomics Abstracts, EiCompendex Engineering, EiCompendex Plus, MEDLINE

Hand searching of bibliographies of selected articles

Quality Control/Peer Review Process:

- Coordinator of project developed search terms in consultation with authors of each question and advisory group.
- A medical research librarian conducted all searches to confirm and improve search strategies.
- Medical librarian and coordinator of project discussed the searches and findings, to ensure that key articles or areas of research had not been overlooked.
- A human factors consultant to the project and a graduate research assistant working with the human factors consultant completed the CAP worksheet for each article that met the inclusion criteria. The coordinator of the project then reviewed the article and the completed CAP to look for unanswered questions and discrepancies in interpretation of the results and to ensure that the implications were clear.
- The CAT was written by the author of the question. It was then reviewed by the coordinator of the project, a staff person at AOTA, and a content expert in the area of occupational therapy and older adult driving and community mobility.

Results of Search

Summary of Study Designs of Articles Selected for Appraisal

Level of Evidence	Study Design/Methodology of Selected Articles	No. of Articles Selected
I	Systematic reviews, meta-analysis, randomized controlled trials	6
II	Two groups, nonrandomized studies (e.g., cohort, case-control)	0
III	One group, nonrandomized (e.g., before and after, pretest, and posttest)	2
IV	Descriptive studies that include analysis of outcomes (e.g., single-subject design, case series)	
V	Case reports and expert opinion, which include narrative literature reviews and consensus statements	1
	Qualitative Studies	
		TOTAL = 9

Limitations of the Studies Appraised

Levels I, II, and III

Limitation of the studies published since 1999 may include lack of randomization, recall bias, little information about recruitment and experimental procedures, and participant groups that do not reflect the composition of the older adult population. In addition, studies taking place in simulated situations do not provide the same challenges encountered in on-road driving.

Levels IV and V

Although the *Highway Design Handbook for Older Drivers and Pedestrians* (Staplin et al., 2001) incorporates an extensive review of the literature, the studies included in the review were not classified with respect to level of evidence, and a critical review of individual studies was not included.

Articles Selected for Appraisal

Carlson, P. J. (2001). *Evaluation of Clearview™ alphabet with microprismatic retroreflective sheetings* (FHWA Report #FHWA/TX-02/4049-1). Springfield, VA: National Technical Information Service.

Carmeli, E., Coleman, R., Omar, H. L., & Brown-Cross, D. (2000). Do we allow elderly pedestrians sufficient time to cross the street in safety? *Journal of Aging and Physical Activity*, 8, 51–58.

Chrysler, S. T., Carlson, P. J., & Hawkins, H. G. (2002). *Nighttime legibility of ground-mounted signs as a function of font, color, and retroreflective sheeting type* (FHWA Report #FHWA/TX-03/1796-2). Springfield, VA: National Technical Information Service.

Guerrier, J. H., & Fu, S-H. (2002). *Elder roadway user program test sections and effectiveness study* Project 669535, contract # BB-901). Miami, FL: University of Miami.

Hing, J. Y., Stamatiadis, N., & Aultman-Hall, L. (2003). Evaluating the impact of passengers on the safety of older drivers. *Journal of Safety Research*, 34, 343–351.

Ho, G., Scialfa, C. T., Caird, J. K., & Graw, T. (2001). Visual search for traffic signs: The effects of clutter, luminance, and aging. *Human Factors*, 43(2), 194–207.

Kline, D. W., Buck, K., Sell, Y., Bolan, T. L., & Dewar, R. E. (1999). Older observers' tolerance of optical blur: Age differences in the identification of defocused text signs. *Human Factors*, 41(3), 356–364.

Staplin, L., Lococo, K., Byington, S., & Harkey, D. (2001). *Highway design handbook for older drivers and pedestrians* (Publication No. FHWA-RD-01-103). Washington, DC: U.S. Department of Transportation, Federal Highway Administration.

This work was completed in August 2005 by Paula C. Bohr, PhD, OTR/L, FAOTA. It includes a summary of *Highway design handbook for older drivers and pedestrians* (Staplin et.al, 2001) and is also based on an evidence-based literature review completed by Kathleen A Harder, PhD.

CAT format adapted from a template provided by Dr. Annie McCluskey and freely available for use on the OT-CATS website (<http://otcats.com>)

For more information about the Evidence-Based Literature Review Project, contact the American Occupational Therapy Association, 301-652-6611, x 2052.



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