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| 16. Abstract This literature review is divided into three parts. Part 1 offers an overview of the elderly driver: demographics, types of trips, accident typology and locations, licensing, and some suggestions for both roadway geometrics and control devices found in the literature. Part 2 is an annotated bibliography that concentrates on (1) demographic findings both for the U.S. as a whole, and for the 5-state region of this University Transportation Center; (2) vision and the elderly driver; and (3) information processing and the elderly driver. Part 3 is comprised of selected abstracts of direct relevance to the research work pursued under this grant. | | | | | |
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Aging Driver Needs for Mobility
in an
Automobile Oriented Region

A Literature Review

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An Overview of the Elderly Driver

Elderly driver profile:

Many elderly drivers are moving to Florida and Arizona. A smaller, although significant, number of these drivers are moving to Nevada, California, or Texas (Transportation Requirements for Elderly, Handicapped, and Economically Disadvantaged). A large proportion of elderly drivers recognize their limitations and have realistic perceptions of their abilities and the traffic risks they face. Because of this reduction in driving abilities many elderly drivers adopt compensatory behavioral strategies. (Effects of Aging on Driver Performance, 1988). These strategies include: driving slowly, taking shorter trips, avoiding high risk traffic situations, avoiding unfamiliar roadways, increasing distance between themselves and other vehicles, and making slower driving maneuvers.

Physical changes that occur in older persons include:

- * general weakness
- * weight leveling off or weight loss
- * muscle strength and power decreases

- * sitting and standing heights decrease
- * functional arm reach can be affected by arthritis
- * flexibility is affected
- * legs and trunk muscles become weakened (more so than arms and hands)
- * grip strength can be affected by arthritis
- * loss of visual acuity and peripheral vision (Effects of Aging on Driver Performance, 1988).

The effect of these changes on the driving task could be studied. In particular research on entry/egress to vehicles, and use of primary and secondary controls could be conducted. This would provide a sound anthropometric database related to stages in aging. These data could then be used in designing vehicles for the elderly. Specific recommendations regarding seat height, eye height, entry, exit, control reach, and seat width could be formulated.

Fifty-one percent of elderly drivers usually use their seat belts. Eighteen percent sometimes use them, and 30% rarely or never use them. Among the difficulties the elderly driver encounters are signs which are, to them, illegible. Even some of the signs which are legible are ambiguous. The aged drivers workload is increased by multiple and complex decision making requirements of intersections and routing points. The designed

decision reaction times may be inadequate for many elderly drivers (Traffic Safety of Elderly Road Users, Paris 1985).

Trip characteristics:

Census statistics show that elderly persons are staying in the suburbs. The advantage of the suburbs for the elderly members of our population is that they can drive to their destinations in the city. In the United States eighty percent of elderly trips are made in private vehicles, with walking secondary. In European countries, public transportation is secondary, followed by walking. Even though the elderly are driving more, the number of miles they drive, decreases.

Most trips made by the elderly consist of shopping, church, and socializing with family and friends. Agencies such as social services, training, and employment are common destinations as well as hospitals, clinics, and recreation (Transportation Requirements for Elderly, Handicapped, and Economically Disadvantaged). Elderly drivers average less than 7,000 miles per year and do not drive on a daily basis. The aged driver minimizes driving required at night, in snow, in rush hours, in fog, and in heavy traffic. They tend to drive on residential roads mainly (43%), business roads (34%), expressways (12%), and rural roads (10%). They also avoid night-time driving and rush hour and concentrate most trips between 12 and 6 pm (52%) or before 12 pm (42%).

Common locations and types of accidents (Effects of Aging on Driver Performance ,1988):

The most common type of accidents for the elderly driver are:

- * Rear end collisions (27.5%)
- * Traffic Signals (19%)
- * Stop/yield signs (14%)
- * Loss of control (13.5%)
- * Backing in driveways (9.5%)
- * Changing lanes (9%)
- * Non-intersection turns (7.5%).

It is reported that elderly drivers cause and are involved in many accidents occurring in parking lots. Overall men have 2.5 - 3 times as many accidents as women above age 50. However, the accident rates for the aged driver, regardless of gender, increase on both interstates and non-interstate highways. Additionally, accident rates increase at intersections and during night driving.

Studies also show that the elderly have trouble maintaining proper speed, observing behind and to the side, using mirrors, and reacting to traffic conditions when in unfamiliar areas. Many accidents involving elderly persons occur within 15 miles of their home. The elderly driver is most often cited for the following:

- * failure to yield
- * changing directions unsafely
- * failure to obey traffic signs and signals
- * careless intersection crossings

- * improper and inaccurate turns
- * careless and improper lane changes
- * careless merging
- * careless backing.

Other causes of accidents cited include errors in assessing speed and distance of approaching vehicles, lack of comprehension of traffic signs, slow judgement and decision-making skills. Additionally, the drivers report that roadways are difficult to maneuver (Traffic Safety of Elderly Road Users, Paris 1985).

Accident figures alone are not a good measure of road safety. Accident figures do not describe the severity and relative amount of traffic in the vicinity (Traffic Safety of Elderly Road Users, Paris 1985).

Elderly driver licensing:

A need exists for better methods to identify and evaluate elderly drivers. Because of the individual differences between persons, limitations are not based solely on age. However, at age 60 or 65, possible tests could be administered on a biannual or triennial basis that would identify limitations due to age. It is suggested that testing should include visual acuity (both static and dynamic), contrast sensitivity, visual field, color vision, and reaction time. These comprehensive tests could determine whether a license should be restricted or even issued.

Functional age is not equal to chronological age. Functional age expresses functional abilities and is dependent on the driver's general state of health: physiologically, psychologically, and socially. To some extent, these factors can be measured objectively (Traffic Safety of Elderly Road Users, Paris 1985). The relationship between functional impairments and driving performance is not entirely clear. This lack of clarity makes specific recommendations regarding licensure difficult. Current research for driver licensing procedures is warranted in these areas (Effects of Aging on Driver Performance, 1988).

Perceptual Research:

- * study the relationships of perceptual processes to safe driving
- * study visual acuity -- especially dynamic visual acuity and how this effects safe driving
- * study the impact of other changes in visual functioning on driving ability

Cognitive Research:

- * study incorrect judgments, memory lapses, reaction time, and other cognitive difficulties as applied to what is required for safe driving. Elderly drivers have

difficulty processing information quickly and making decisions and reactions quickly.

Psychomotor Research:

- * study the impact of decreased muscular strength, arthritis, and other conditions as applied to driving tasks. Elderly drivers often lack the energy and physical ability to resolve conflicts.

- * Rheumatism and arthritis may affect steering, causing an elderly person to steer too widely. Sudden reactions needed, may be difficult because of joint stiffness.

Some states place restrictions on elderly drivers such as the number of miles that can be driven, the times of day, and the type of driving (highway vs. rural roads). Kansas tests drivers every four years; Texas every three years.

Roadway changes:

Most traffic engineering is based on an identified design driver. A question exists whether the design driver adequately represents the elderly driver. Elderly drivers need longer site

distances, especially at intersections and no passing zones. The aged driver would benefit from traffic signs that have larger letters and higher contrast without glare. Redundant traffic signs should be placed when appropriate. Traffic signals should have longer timing intervals and possibly brighter lights. Dynamic signs should be used more often to catch the elderly driver's attention.

Traffic controls devices should be placed in locations where they can be best seen and understood. Pavement markings should be brighter in areas where there are many elderly drivers. On/off ramps should be lengthened in many cases. Research in these areas is needed to determine what specifically exists now, and whether or not it adequately meets the needs of the elderly. This can only be done by testing with elderly drivers (Effects of Aging on Driver Performance, 1988).

Flashing signals at intersections have been found to be more confusing for elderly drivers; signals that are on cycles are less hazardous.

Roadway structures should be simplified to minimize intersections, branching, and freeway interchanges (Traffic Safety of Elderly Road Users, Paris 1985). More one-way roads should be introduced that eliminate tricky maneuvers and intersections. Traffic flow should be separated and relevant decisions required should be staggered. Road surfaces and alignment should be improved. Signs should be placed early enough to give elderly drivers adequate time to decide. Signs should impart simple,

coherent, and complete messages. They should be adequately lighted. Speed limits should be reduced where decision-making is involved.

Vehicular changes:

Because of the presbyopia that most older drivers experience, bifocals are often used to help focusing on nearby objects. This impacts the reading of displays because most bifocals are adjusted for a reading distance of approximately 12-15 inches. Dashboard controls are typically located at 20-27 inches. Therefore, even though the driver is wearing bifocals, he or she must move their eyes closer to the dashboard displays to be able to see them clearly. Enlarging the displays is one possible solution.

Older drivers also have difficulty accommodating quickly from observing the roadway to observing the dashboard displays. Larger displays would also help alleviate this problem.

A study was done to determine the best color to use in displays based on performance and preference. It was found that the color with the best overall results was a blue-green. However, older drivers least preferred this color and found yellow and orange the most attractive and easiest to read. Older drivers are often insensitive to blue because of the yellowing of the lens and all colors are less vivid.

Research on display colors is indicated, especially given the low illumination levels inside vehicles. Eight times the amount of light is needed at age 60 as is needed at age 20. Possible

research could be done on required highway and roadway lighting at night, especially in areas where there are many elderly drivers.

Blue should not be used to present detailed information and fine lines, however both blue and yellow are appropriate for background colors.

There is little research currently on whether displays for older drivers should be digital or analog. Some studies have shown that pointers are better than numeric displays. Also gauges have been shown to require lighter demands on attention than digital displays that require longer processing times. This is important especially for older drivers because they need as much time as possible to observe and react to traffic conditions.

Glare is a problem for many drivers, but especially elderly drivers. This is because of a thickening, yellowed lens, a smaller pupil, and the opaque humor of the eye.

Headlamps used in the US give off more glare than European headlamps. However, there is no evidence that the European headlamps result in a better driving system. This could be a possible research area (Effects of Aging on Driver Performance, 1988).

It is proposed by some that financial aid be made available to assist in adapting and maintaining vehicles to meet elderly drivers' needs ("Social Service" Transport: Transport for Elderly and Handicapped Persons, Paris, 1980).

Misc notes:

The AARP estimated that in 1988 they had membership of over 30 million. This is 1/2 of all persons over age 50. They currently add 1/4 million members per month! They estimate that by 1992 60% of all Americans over 50 will be members.

The AARP offers a course for elderly drivers that is popular and is conducted in many states. The Denver Driving school once offered a course in pedestrian safety, winter/mountain driving, state/local traffic laws, safety belt use, safe driving techniques for new roadways, in heavy traffic, and at higher speeds. They used a simulator and reactometer to determine age-related physiological changes. Many other locations have offered courses, that now have been discontinued, except for the AARP course.

Driver performances that could be studied include:

- * handling time
- * direction changes
- * boundaries
- * observation -- in front, to side, and behind
- * positioning
- * applying brakes to make rapid stops
- * lanekeeping -- on straight roadways, in curves, and in making turns
- * gap selection
- * maintaining speed -- on straight roadways, in curves, and in making turns
- * selecting speeds for curves and turns

* lane changes

An Annotated Bibliography

Demographic Profile of the Elderly Driver

United States (Demographic data from A Profile of Older Americans, 1986)

1. From 1980 to 1985 the 65+ population increased by 11%, while the under 65 group increased by 4%.

2. In 1985 the sex ratio for 65+ group was 147 women for 100 men.

3. Since 1900 the % of population 65+ has tripled.

4. The older population itself is getting older. In 1985 the 65-74 age group (17.0 million) was nearly 8 times larger than in 1900, but the 75-84 group (8.8 million) was 11 times larger and the 85+ group (2.7 million) was 22 times larger.

5. A child born in 1985 could expect to live 74.7 years, about 27 years longer than a child born in 1900.

6. The most rapid increase of 65+ group is expected between the years 2010 and 2130 when the baby boom generation reaches age 65. By 2030, there will be about 65 million older persons, 2.5 times their number in 1980.

7. In 1985, about half (49%) of persons 65+ lived in 8 states. California, New York, and Florida had over 2 million each, and Illinois, Michigan, Ohio, Pennsylvania and Texas each had over 1 million.

8. Persons 65+ were less likely to live in metropolitan areas in 1980 than younger persons (71% of the elderly, 75% of persons under 65). About 32% of older persons lived in central cities, and 39% lived in suburbs.

9. In 1985, about 800,000 persons 65+ had moved to a different state since 1980. Of these over one-third (35%) had moved from the Northeast region or Midwest region to the South or West (compared with 26% for younger persons).

Five State Region (Data from Projections of the Population of States)

1. Arkansas: In 1986 14% of the population was 65+ (343 thousand), by 2010 17% of population will be 65+ (435 thousand). By 2010 the 65+ group will be 1.4 times larger than their number in 1980 (311 thousand).

2. Louisiana: In 1986 10% of the population was 65+ (454 thousand), by 2010 13% of population will be 65+ (577 thousand). By 2010 the 65+ group will be 1.42 times larger than their number in 1980 (405 thousand).

3. New Mexico: In 1986 10% of the population was 65+ (145 thousand), by 2010 11% of population will be 65+ (253 thousand). By 2010 the 65+ group will be 2.18 times larger than their number in 1980 (116 thousand); this increase is greater than other States in the region.

4. Oklahoma: In 1986 12% of the population was 65+ (411 thousand), by 2010 14% of population will be 65+ (504 thousand). By 2010 the 65+ group will be 1.34 times larger than their number in 1980 (377 thousand).

5. Texas: In 1986 9% of the population was 65+ (1584 million), by 2010 12% of population will be 65+ (2613 thousand). By 2010 the 65+ group will be 1.91 times larger than their number in 1980 (1371 thousand).

Older Drivers, The Age Factor in Traffic Safety, NHTSA Technical Report, DOT HS 807 402, February 1989.

1. On an absolute basis, motor vehicle crashes are not significant cause of death for older persons.

2. Teens have 23 times the number of crashes of 80 yr. olds.

3. When crash frequencies are adjusted for population totals, similar but smaller differences were found ie. 5.4 compared with 23 as above.

4. Involvement rates based on vehicle miles of travel follows a U-shaped curve: 16-19 yr. olds = 30/1,000,000 ; 35-65 = 4/1,000,000 ; 85 yr. = 40/1,000,000.

5. Based on Crash Experience, older drivers:

- * drive in urban areas

- * drive in daylight

- * are more likely to be charged for violations

- * tend to be involved in intersection crashes
- * tend to be involved in fewer single vehicle crashes
- * commit higher proportion of "Right of Way" and "Traffic Signal" violations.

6. Little difference in the severity of accident based on age.

7. Fatalities and Seriousness of Injuries increase with Both severity of crash and age of driver.

Transportation in An Aging Society, Vol. 1, Special Report 218
(Citations refer to original text.)

Page 54 Functional dependency of older people. age 65-74
12.6% impaired. Age 75-84 25.0% impaired. (Soldo and Longino
1988).

Assessing the Driving Ability of the Elderly

Page 8. Eleven per cent of population age 65 or older in 1980.
Fifty-Seven and nine-tenths percent of those over 65 are
licensed to drive.

Elderly driver compared to the average driver:

- * drives 30-50% less
- * is more cautious
- * drives shorter distances
- * stops more often
- * drives less in bad weather or at night
- * avoids rush hour traffic
- * avoids major highways
- * is most often a male driving less than when he was younger
- * makes slower and fewer lane changes
- * breaks more and accelerates less.

Page 9. Most troublesome maneuvers for the older driver are changing lanes, left turns, enter expressways, and reading signs.

Most frequent violations: failure to signal, following too close, traveling too slowly, turning improperly.

The aged driver has problems with signs, right of way, and passing

Page 11. Drivers self-rate themselves worse than do observers on;

- * easily distracted

- * misjudge situations

- * forgetful

Drivers self-rate themselves better than do observers on;

- * signaled appropriately

- * paid full attention to the road.

Page 12. Drivers are overconfident of ability to avoid accidents. The actual chance of accident in one year is 1:7. Forty-two percent of the survey rated chances as 1:500 while more than 50% of those over 50 yr. rated chance as 1:1000 and over 1/2 of 50+ drivers perceive themselves as having total control over having an accident.

Vision and the Elderly Driver

Transportation in an Aging Society, Vol. 1, Special Report 218
(Citations refer to original text.)

Page 54 Older persons report problems with traffic signs
(Yee 1985) (Kosnik et.al.1986).

Page 55 Reduced visual acuity with age.(Bailey and Sheedy.
Vol 2 p 295).

Page 55 Loss of ability to focus on static or moving object
with age (Weale 1963).

Page 55 Increase in glare sensitivity with increase in age
(Wolfe 1960).

Page 56 Static Visual Acuity declines with age. Constant
until 50 then rapid decline. About 2/3 of 65-75 yr. old
corrected to <20/20 vs. 13% for 18-24 (Bailey and Sheedy Vol.
2 p 29).

Page 57 Small but significant correlation accidents x static
acuity in drivers over 54. Low light and poor static acuity
predict accidents (Shinar 1977).

Page 57 Dynamic Visual Acuity decreases with age (Reading 1968).

Page 57 The visual field is reduced in older persons. Of those over 60 yrs. old 13% had reduced visual field. Of those with reduced field, 50% did not know they had a problem (Johnson and Keltner 1983).

Page 57 Contrast Sensitivity, Glare Recovery, Distance perception, Visual Search , and age (Kline 1986) (Balley and Sheedy Vol. 2) (Schiber Vol. 2).

Page 66 Letter height for signs Inch high letters visible at 50 ft. based on research by Forbes in the 1930's. Assumes approx. 20/25 (Forbes and Holmes 1939).

Page 66 40% of drivers 65-74 do not see as well as 20/25. At age 75 the 95%ile is closer to 20/40 (Sheedy Vol 2).

Page 66 Low light visual acuity for older drivers 62-79 Day 20/18 vs. Night 20/42 (Sival et al 1981).

Page 66 Older driver has legibility distance of 65-75% of driver 18-24 (Sival et al 1981).

Transportation In An Aging Society, Vol.1, Special Report 218.

Page 78 Signs

1. Increase size of lettering on signs.
2. Use higher reflectivity sign material.
3. Use multiple signing.

Page 80 Roadway markings

1. Use edgelines at any high-hazard location.
2. Increase edgeline marker from 4 in. to 6-8 in.
3. Increase priority of upkeep of current marking.

Page 87 Headlight performance

1. During daylight eye of older driver gets 1/3 light of teenager. At night older eye gets 16 times less than teen.

Assessing the Driving Ability of the Elderly

Page 15. Peripheral vision declines with age, 170 degrees at age 35, 140 degrees by age 50. Peripheral retina is sensitive to targets that move very short distances at high speeds. Peripheral retina is less sensitive with age.

Page 17. As the lens thickens and yellows it becomes less sensitive to colors having shorter wavelengths ie. blue and green.

Page 20. A 55 yr. old takes 8 times as long to recover from glare as a 16 yr. old. To see low contrast objects, older persons require twice the illumination of a younger person. Twenty Year old gets 3 times the light at the retina of a 60 yr. old. Required Illumination doubles for every 13 yrs. to get equivalent performance on test tasks.

Redesigning America-Age Wave

Page 314. The young eye can see light blue, pink and salmon as distinct shades but become difficult or impossible to distinguish for the older eye. Black, gray, dark blue and dark brown look alike to the older eye.

Physical fitness and the Aging Driver

Page 8. Loss of available light is equivalent to a 10% reduction for normal designs as seen by older eyes. Incidence of visual field loss is about 13 % for 65+yr. Half of those with field loss are not aware of the loss.

Information Processing and the Elderly Driver

Transportation in an Aging Society, Special Report 218, Vol. 1

(Citations from original text.)

Page 55. Four Phases of the driving task. (Smith 1968).

a. See or hear a situation developing (Stimulus register and sampled at perceptual level).

b. Recognize it (stimulus recognition at cognitive level).

c. Decide how to respond (cognitive level).

d. Execute physical maneuver (motor level).

Page 55. Decrements in ability to concentrate with age.

Page 55. Review of Literature to link lab studies with driving tasks. (Kline 1986).

Page 58. Inattention contributes to 25% - 50% of all crash
e s
(Shin
ar et

Page 59. Focus of attention decreases with age. (Botwinick 1978)

Page 59. Ease of distraction increases with age (Kausler 1982)(Staplin 1987).

Page 59. There is a decline in the ability to correctly judge distance as people age(Hill and Mershow 1985).

Page 59. Older people overestimate the Speed of an oncoming car and underestimate the distance of the oncoming car. However, the overestimate of speed is not enough to compensate for the underestimate of distance. May contribute to the turning accidents characteristic of older drivers.(Kline 1986).

Page 59. There is a decline in the performance of older people on complex multifactored tests(Staplin 1987,93)

Page 60. Slower information processing and mild memory loss is a normal part of aging(Katzman 1985).

Page 60. Medication induced cognitive problems.(McKnight Vol 2).

Page 60. Speed of motor response decreases with age(IOM 1981 116;Staplin et.al. 1987,101).

Page 60. Decrease in Reaction Time probably due to slower decision process.

Page 60. The effect of health on performance does not show a single age where a sharp decline occurs(IOM 1981,144).

Page 62. Most persons between 65 - 85 and more than 1/2 over 85 report health good. No limitation in daily life.

Page 63. Perception - Reaction time of 2.5 sec is assumed for determining behavioral component of stopping sight distance: 1.5 sec allowed for braking, 1 sec allowed for perception (American Association of State Highway and Transportation Officials).

Page 63. Eighty-fifth percentile = .85-1.86 sec. break-reaction time. Ninety-fifth percentile = .88-2.36 sec. Lower estimates from studies 1925-1953. Estimates 85%ile as high as 3.2 sec. (McGee et al 1983).

Page 63. 95%ile break - RT 1.6 sec. (Olson 1984).

Page 63. Intersection sight distance. Perception-RT vary from 2.5-3.0 sec. (McGee et al 1983,7-9).

Page 63. Allow 2.0 sec for driver to look both ways,decide to cross and initiate action. This is based on performance of trucks not cars. (Hauer, Vol 2,p219).

Page 63. Raises the question "What is the distribution of perception-bread reaction time across the population of drivers under various conditions?"

Page 66. Susceptibility to visual clutter increases with age(Kosnik et al 1986)(Sekulen 1986)(Mace vol 2).

Page 66. Older drivers reduce speed to increase time to find sign, read sign, and maneuver but it is better for traffic flow and safety to maintain uniform speed (Hauer 1971).

Page 66. Older driver has increased probability of being in a fatal crash with younger driver than with one their own age. She suggests the juxtaposition of high speed characteristic of younger driver and the low speed of older driver causes the increase in the probability of crash(Partyka 1983)

Transportation in an Aging Society, Special Report 218, Vol. 2

(Citations from original text)

Page 253. Guidance through intersections is accomplished almost exclusively with traffic control devices such as route markers and direction and street signs.

Page 254. At non-intersection locations, guidance comes largely from the visual perspective of the road ahead and the location of parallel elements such as lines of trees, fencing, utility poles, parked cars and lighting standards. For tracking, the driver relies on nearby features; contrasts in color, texture, and shape between pavement and shoulder; curb and barrier edges; and pavement striping. Under high traffic volumes, car following is likely a dominant tracking and guidance aid. The vibration and noise of an inadvertent excursion onto a properly textured shoulder also serve to alert the inattentive driver. Specific visual capabilities essential to guidance and tracking have not been accurately identified. Visual acuity and contrast sensitivity are probably the most critical visual elements for identifying distant features essential to the guidance task.

Page 255. Tracking requires identification of closely located features, typically outside of the point of visual fixation, therefore peripheral vision.

Page 256. (A) centerlines reduce crash rates. (B) RPMs reduce crash rates more than centerlines (cost-effective at 3k/day). (C) edgelines reduce crash rates(cost-effective at 1k/day).

Page 259. Edgelines: (A) reduce turning curvature. (B) move vehicle to more central location. (C) increase night time speeds. (D) reduce shoulder encroachments. (E) reduce variability of position and speed especially at night.

Page 275. Driver motivation and expectancy should be considered when determining the conspicuity of a sign: (A) guide signs. (B) size and placement. (C) luminance. Elderly drivers look at irrelevant stimuli.

Page 276. Do not confuse threshold with conspicuity. An age effect is present when visual search is required but is absent in the absence of search.

Assessing the Driving Ability of the Elderly

Page 23. Older subjects(mean age 78) have more difficulty with figure ground discrimination than younger subjects(mean age 27). Driving performance and figure-ground discrimination in the able-bodied vs. brain damaged indicates a direct relationship between degree of impairment and level of driving performance. Visual discrimination and figure-ground skills may appear normal until work load or emotion become involved.

Page 40. Post Hoc examination of test data regarding figure-ground discrimination and frequency of driving indicate a 16 pt. spread between frequent and infrequent drivers in sample. Self-assessment is not a significant predictor of driving performance.

Page 46. As the reported frequency of driving increases, the number of correct figure - ground responses increases and the time to respond decreases.

Aging Sensory Systems and Perception

Page 60. In a test of the ability to see an ambiguous figure, the young group(age 19-34) was able to see the alternate figure in 24 of 29 cases while the older group(age 65-81) were

able to make the reversal only 8 out of 34 times. The above task may require a perceptual span greater than that available to the older subjects.

Physical fitness and the Aging Driver

Page 5. Information Processing model of Reaction Time = 200 ms
a. 40 ms for detection. Onset of stimulus to evoked R at Occipital lobe.

Page 9. Visual masking. Older persons require longer critical periods to escape masking effects. First stimulus may last longer in the central nervous system. This could lead to stimulus over load in traffic.

Page 10. Older drivers have a problem "ignoring meaningless information and correctly id. meaningful cues."

Page 10-11. High levels of arousal might hinder motor performance on tasks that require fine control, steadiness, and rapid decisions. Tasks that are self-paced and have no time limits show less marked age declines. Older people drive better when they can control their own pace. Decline in recognition among the elderly can be attributed to increased perceptions of stress and not merely advancing age.

Confidence, cautiousness, motivational state , vigilance, and other personal characteristics are all elements that need to be controlled or evaluated systematically when examining the relationship of age to perception and attention in a traffic setting. A wide variety of information-processing studies support the hypothesis that more complex tasks result in greater performance deficits for the elderly.

Page 16. Age related functional declines have a greater effect on the central mental processes than on the peripheral functions. Therefore most older driver safety problems relate to tasks that are heavily dependent on central processing. These tasks involve response too traffic or roadway conditions.

Page 17. Compensatory Practices; change amount and type of driving, avoid night, intersections, and bad weather, reduce speed, and increase precision.

Page 20. Oxygen deprivation may contribute to reduced information processing.

Safe and Unsafe Performance of Older Drivers:A Descriptive Study

A good collection of critical incidents involving the older driver. Reports of truck drivers, police, and AARP instructors.

Selected Abstracts

Ruediger Lamm, Elias M. Choueiri, and Juergen H. Kloeckner
1987 Experiences in fatalities by age and road user
groups--U.S.A. vs. Western Europe 1970-1983. Pp. 128-144 in
Proceedings of Roads and Traffic Safety on Two Continents
(Conference) in Gothenburg, Sweden 9-11 Sept. 1987. Driver
Behavior and Licensing, Alcohol and Drugs, Driving and
Elderly. U.S. Dept. of Commerce, National Technical
Information Service. Report No. VTI-331A.

Abstract

The objective of the study were: (1) to identify various changes in fatalities and fatality rates for different age and road user groups, as experienced by 11 Western European countries and by the United States from 1970-1983, and (2) to determine whether there were statistically significant changes in the traffic accident characteristics studied.

For Western Europe as a whole it was found that all age and road user groups showed significant or at least marginal improvements in safety for the entire time period observed: however, the U.S. experienced significant deterioration human and vehicular involvements, especially during the second half of the 1970's. Contrary to this trend, the study determined

that since 1980 the fatality reduction in the U.S. was nearly similar to that of Western Europe and that most age and road user groups revealed significant improvements in safety in both continents.

Data Base: (1) United Nations' "Statistics of Road Traffic Accidents in Europe"

(2) U.S. Dept of Transportation "Fatal Accident Reporting Systems"

Test of significance: T-statistics

Kare Rumar 1987 Elderly drivers in Europe, Pp. 145-167 in Proceedings of Roads and Traffic Safety on Two Continents (Conference) in Gothenburg, Sweden 9-11Sept. 1987.

Driver Behavior and Licensing, Alcohol and Drugs, Driving and Elderly. U.S. Dept. of Commerce, National Technical Information Service. Report No. VTI-331A.

Abstract

Elderly citizens of today are healthier and wealthier than in the previous generation. The car plays a steadily increasing

role in their social life. Without it they run the risk of being socially isolated. Such an isolation speeds aging while contacts and activity delays it. The elderly need the car.

This paper concentrates on the question whether the ageing driver is a safety problem and if so why and what can do about it? Initially it is shown that the elderly driver has a higher accident rate than the middle aged. The problem with older drivers will increase in the years to come since the proportion of the elderly drivers will increase. The handicaps of the elderly are of physiological and cognitive character. But these limitations are partly compensated mainly by increased caution. The influence of these seven specified driver tasks (planning, navigation, road following, traffic interaction, speed control, rule compliance, and vehicle manoeuvring) is discussed.

Accidents: lower than younger aged; higher than middle aged. more likely to have fatal accidents occurring from crossing collision (left-hand turns) and head-on collisions than 15-64 age group. Injury: when the elderly road user is injured the treatment and rehabilitation take much longer time and higher costs.

Effects of aging: Vision: low levels of illumination, dynamic situations, low contrasts, and accommodation capacity.

Hearing: loss of hearing; studies have shown this not as important for driving as vision.

Mobility: Muscular force and speed decline with age reaction time slower; capacity to turn head lessens.

Pathology: Illness requiring medication.

Cognitive: Short term memory and decision time decreases.

Behavior of Elderly Driver: Strategic point: older drivers more often chose another mode of transportation than driving.

Reasons: perception of the physiological and cognitive limitations, more cautious, avoiding stress, and less dependent on time.

Navigation: elderly driver is handicapped in unfamiliar situations and even more so in dense traffic and night traffic.

Reasons: limitations concerning vision info input, info processing, short term memory.

Road tasks: no problem if can chose pace--can choose position and course on road.

Traffic tasks: interaction with other road users--most problem

for elderly.

Manoeuvring: not a problem if at a speed they can handle.

Speed: not a problem if at a speed the can handle.

Gunter Kroj, 1987, Driving and the Elderly, Pp. 166-178 in Proceedings of Roads and Traffic Safety on Two Continents(Conference) in Gothenburg, Sweden 9-11 Sept. 1987. Driver Behavior and Licensing, Alcohol and Drugs, Driving and Elderly. U.S. Dept. of Commerce, National Technical Information Service. Report No. VTI-331A.

Number of Licensed elderly increasing.

There are clear indications that elderly people now continue to lead an increasingly active life--physically, psychologically, in their human relations and professionally--despite the age-related decline of their maximum functional abilities. However, a higher quality of life for the elderly also implies the greater probability of continuing active participation in the everyday life of society. This is also

characterized by an increasing use of the driving license after the age of 65.

Reduction of maximum physical and mental capacity:

According to the opinion the Joint OECD-WHO group this should be accounted for by facilities on the sectors of public transportation and road traffic as well as by safety improvements for vehicles.

More likely to have fatal accident than 25-64.

Accidents: reasons--overlooking signs/disregarding rules at intersections.

Elderly driver's vehicles: buy more frequently new cars & cars in the higher engine displacement category. They value driving comfort & willing to pay it.

James M. Witkowski and Thomas R. Buick 1985 Travel Behavior of Residents Communities. Pp. 13-21 in Transportation for Elderly and Handicapped Persons, Paratransit, and Ridesharing: Transportation Research Record 1018. TRB/TRR 1018. Transportation Research Board.

Abstract

Urban travel estimate is reviewed in the context of a growing elderly population and the trend of development of retirement communities. The life-style characteristics of retirement communities are uniquely different from those of virtually all elderly groups previously studied, and the mobility of the inhabitants appears to be reflected in this life style.

Traditional, and newly developed, travel demand models fail to incorporate parameters that account for the significant variation in travel demand of elderly people that exists as a function of lifestyle. An alternative trip generation model is proposed that would estimate travel demand of elderly people on the basis of life style using measures of age, dwelling unit type, employment status, and discretionary or obligatory travel.

Sample: Arizona (Green Valley, Sun City & Sun City West)
1980 census--60+, mainly retirees--white, affluent, married couples, well educated and living in detached single family homes that average fewer than 2 persons per household.
trips--shopping, dining out, medical & entertainment purposes.

Conclusion:

As the proportion of elderly people in the pop. is growing, the attractiveness of retirement communities appears to be an increasing trend.

On the basis of the life-style characteristics of the inhabitants of retirement communities, their travel behavior would appear to be uniquely different from that of the elderly groups previously described in the literature. Their propensity to travel would appear to be much higher, with a large portion of trips having destinations within communities.

Sorting of housing into categories such as apartments, extended care facilities, nursing homes, and single-family detached housing appears appropriate for improving travel demand estimation for the elderly population.

Birth date and descriptions of dwelling unit type appear to have a high potential for use as independent variables in a life-style based travel demand estimation model.

Existing travel demand models generally fail to incorporate the effects of aging beyond 65 years of age on travel demand and fail to recognize the diversity of life styles of elderly persons.

William G. Bell and Joseph S. Revis 1984 The direction of national developments in specialized transportation in the United States. Pp. 37-45 Third International Conference on

Mobility and Transport of Elderly and Handicapped Persons:
Conference Proceedings Final Report October 1984.
DOT-1-85-07. Washington D.C., U.S. Dept. of Transportation;
U.S. Dept. of Commerce.

P.44 Car ownership will be maintained by a high proportion of older people. Given the alternative life styles of older people of the 1980's, the high costs of owning and operating an automobile and parking in urban areas, older people will make selective use of specialized transportation for trips. The automobile may be reserved for hard to reach locations and places to which specialized transportation is difficult to obtain or unavailable.

Martin Wachs 1979 Transportation for the Elderly: Changing Lifestyles, Changing Needs. Berkeley: University of California Press.

Pp. 2-3 The elderly of the future, however, will be more heterogeneous, more affluent, more educated, dispersed in a variety of living environments, and more likely to drive. The trend for the last twenty years has been toward lower density living and increasing reliance on the automobile by senior citizens, and it is probable that this will continue as those

who moved to suburban areas after World War II reach retirement age.

Elderly--increasing political power.

Study: Analyzing Los Angeles over 2 year period to determine travel behavior. Found elderly pop is heterogeneous in its settlement patterns, financial status, participation in the labor force, and the tendency to move with advancing age.

Significant association between lifestyle patterns of the elderly and their travel pattern.

Lifestyles: Spanish American Community, New Suburbanites, Black Community, Central City Dwellers, Early Suburbanites, Financial Secure, and Institutionalized.

Pp. 206-207 Future Travel Patterns in L.A.

The analysis demonstrated that, regardless of lifestyle area, most trips will be made for personal business. In addition, trips by the elderly in the future will be predominately by the automobile driver mode, while public transit will be the least utilized of the modes considered in this study.

Nevertheless, public transit will remain an important mode of travel particularly for the Spanish-American, Black and central-city lifestyle areas.

James E. Birren, Anita M. Woods, and M. Virtue Williams 1980
"Behavioral slowing with age: Causes, organization, and
consequences". Pp. 293-308 in Leonard W. Poon (ed.), Aging in
the 1980: Psychological Issues. Washington, D.C.: American
Psychological Association.

Abstract

In the matrix of relations between the physiology, anatomy, and behavior of the older nervous system, a particular vantage point is research on the slowness of behavior with age. A review of the evidence indicates that the slowing behavior with age not only appears in motor responses and sensory processes but becomes more obvious with increasing complexity of behavior. For this reason the expression "slowness of behavior with age" is preferred to the more limited phrase "changes in reaction time with age." While there are probably both general and specific factors in behavioral slowing with age, the organization of a general factor of slowness raises some fundamental questions. Behavioral factors are apparently involved, but more recent emphasis has been placed on the role of the neurobiological changes in the central nervous system.

J. A. Stern, P. J. Oster, and K. Newport 1980 "Reaction time measures, hemispheric specialization, and age." Pp. 309-326 in Leonard W. Poon (ed.), Aging in the 1980's: Psychological Issues. Washington, D.C.: American Psychological Association.

Abstract

Decision and transit time components of reaction time were abstracted from left to right indexed-finger response recorded as 240 participants (whose ages ranged from 7 to 79 years) performed nonverbal, visual detection tasks or a visual detection task conducive to verbal processing. For adults only, cerebral asymmetry effects were demonstrated. Faster left-hand decision time, and by inference more efficient right-hand hemisphere processing, was found for nonverbal, visual detection tasks but not for the visual detection task conducive to verbal processing. The amount by which adults' left-hand decision times in the nonverbal tasks did not change with age. The result places limitations on the generalization that the aging process has a more determined effect on nonverbal and presumably right-hemisphere processing than on verbal, sequential, and presumably left-hemisphere processing. Evaluation of transit time revealed significant age-dependent effects. While this result contradicts much of the literature, different findings may be a function of task used. If tasks involve large-amplitude motor responses, there may be

no differences as a function of aging, while if tasks, like those used here, involve small-amplitude precision movements of fingers, differences may emerge.

Walter R. Cunningham 1980 "Speed, age, and qualitative differences in cognitive functioning." Pp. 327-331 in Leonard W. Poon (ed.), Aging in the 1980's: Psychological Issues. Washington, D.C.: American Psychological Association.

Abstract

The stability of factor structure of intellectual abilities with age is considered. In one longitudinal study and three cross-sectional studies carried out by the author no change was found in the number of factors, nor were there any psychologically important changes in the pattern of factor loading. Factor covariances tended to become most pronounced for high-speeded demand tasks (e.g., perceptual speed measures). The absence of a reduction in the number of factors, even the older group, precludes clear support for the dedifferentiation hypothesis. Although the increased factor covariances with age might be construed as supporting dedifferentiation, given these results, a greater interdependence of abilities in latter life seems a more

plausible explanation than outright dedifferentiation.

John Cerella, Leonard W. Poon, and Diane M. Williams 1980 "Age and complexity hypothesis." Pp. 332-340 in Leonard W. Poon (ed.), Aging in the 1980's: Psychological Issues. Washington D.C.: American Psychological Association.

Abstract

The reaction-time literature was surveyed with respect to the hypothesis that more complex tasks result in greater performance deficits for the elderly. This hypothesis was supported by data from 18 studies encompassing a variety of information-processing tasks and appears to be a consequence of proportional slowing of the mental functions of the elderly. Two levels of deficit were seen in the data, a slight slowing on sensorimotor tasks and a more severe slowing on tasks involving mental processing.

Merrill J. All1985 "Vision of the older driver: implications for vehicle and highway design and for driver testing" Pp. 1-7 in James L.Malfetti (ed.), Needs and Problems of Older Driver. Colloquium, Orlando Florida. Feb. 4-7, 1985.

Vision Problems:

1. Visual Acuity--focusing problems

To help compensate for this problem, the designers of the highway-vehicle systems need to design for a longer response time than the 2.5 seconds design time recommended by the American Association of State Highway Officials; or they need to provide improved vehicle, highway and signal systems that compensate for the degrading factors. Current deficits in design are themselves responsible for the 2.5 second response time recommended by AASHTO.

2. Loss of light intensity in the eye.

A 6 mm diameter pupil in youth can reduce to a 2 mm diameter pupil in old age, a reduction $1/9$ the area and thus $1/9$ of the light available at the retina. Lens in the eye typically browns with age. The combined losses of available light in the eyes of many older people can easily be equivalent to reducing street and automobile lighting to 10 % (or less) of their normal design levels- reason don't drive at night.

3. Cataract

Reduces the contrast in the retinal image so that low-contrast objects may not be seen--oncoming headlights become excessively glowing.

4. Glaucoma

Gradual loss of visual function beginning in the periphery.

5. Senile macular degeneration

A loss of vision in the important central (macular) vision area due to neurological damage.

Design of Vehicles and Roadways

1. Skyband at the top of the windshield is desirable but not tinted windows.
2. Windshield removal or resurfacing should be made inexpensively available to the motoring public.
3. Wider, brighter pavement striping for edge, center line and lane delineation.
4. Use of larger signs with more attention to clarity of the message.
5. Signs should be designed to provide 13 seconds or more of advance warning time.
6. Amber signal time on stop lights should be increased.
7. All vehicles using the streets and highways should be

required to have the headlight height and spacing within a few inches of one another so that headlight aim and light-output pattern can minimize headlight glare for everyone; same with tail-lights.

8. Brighter lights warning lights at railroad crossings.

Adele M. Milone 1985 "Training and retaining the older driver," Pp. 38-44 in James L. Malfetti (ed.). Needs and Problems of Older Drivers: Survey Results and Recommendations. Proceedings of the older Driver. Colloquium, Orlando Florida. Feb. 4-7, 1985.

Conclusion p.41

It is apparent that a significant segment of the population is not having its needs met. Driver improvement programs of a generic nature do not meet the criteria. The alternatives for older persons are reliance on relatives and friends, public transportation, or vehicles for hire. All of these fall short of accomplishing the goal of independence and mobility for nearly 1/4 of our population.

More programs need to address the specific problems discussed. Training or retraining improves capabilities, lending to the reduction of accidents and making the nation's

roadways safer. Local governments, service organizations, and community businesses can play a significant role in addressing this area of concern through funding, through public awareness seminars and course sponsorship. But they need to be alerted to the need for and ramifications of driver improvement programs. for older motorists and the value of providing and/or sponsoring such programs. Through their participation more older motorists can be reached, programs expanded, and the goals of independence and mobility for the driver achieved.

David Solomon 1985 "The older driver and highway design." Pp. 55-62 in James L. Malfetti (ed.), Needs and problems of older drivers:survey results and recommendations. Proceeding of the older driver. Colloquium, Orlando Florida. Feb. 4-7, 1985.

Older drivers drastically reduce their travel, especially at night. Therefore, although their physical faculties are diminished and they experienced higher mileage-based accident rates, the annual number of accidents they accumulate is no greater than that experienced by younger drivers.

The best way to accommodate older drivers is to provide

highways that are easy to drive on i.e., Interstate Highways or Freeways. These provide safety and free flow of traffic for all drivers, including older ones. The details of highway design should accommodate the 99th or even 99.99th percentile and not the average driver. Efforts to restrict older drivers produce little benefit.

Kenneth Elder and Mary Holly 1974/5? Needs of Elderly Texans.
Center for Studies in Aging. The School of Community Service.
North Texas State Univ. Denton, Texas.

Statewide survey of noninstitutional Texans 60+

Concerning Transportation Problems:

Lack of easy access to transportation limits the independence of the elderly, restricts their activities, and impedes their ability to take advantage of desirable services. The elderly who have no transportation problems are usually those who are able to own and operate their own cars.

In general females, minority respondents, and older respondents with health problems or disabilities expressed the most difficulty in obtaining transportation. These groups

also indicated a greater reliance on modes of transportation other than their own automobile, particularly the dependence on friends and relatives for transportation.

Many of the problems encountered by the elderly are related to transportation. For example, a substantial proportion of those indicating difficulty in obtaining medical care reported that transportation to the doctor was the primary source of difficulty. Most older people with transportation problems are able to get to the doctors or grocery store with difficulty, but their social activities are severely curtailed. A very pronounced inverse relationship between income and indicated transportation problem is evident.

Mitchell E. Reff and Edward L. Schneider 1982 (Eds.) Biological Markers of Aging. NIH Publication No. 82-2221 U.S. Department of Health and Human Services. National Institutes of Health and Public Health Service. Proceedings of Conference on Nonlethal Biological Markers of Physiological Aging on June 19/20, 1981.

John F. Corso "Auditory Clinical Markers of Aging" pp 210-219

* Of the most prevalent chronic conditions which affect the physical health of the elderly, impairment of hearing ranks second only to arthritis.

* Most common source of auditory deficiency is presbycusis. Presbycusis is characterized by a progressive bilateral loss of hearing from both tones and speech due to degenerative physiological changes in the auditory system on a function of age. The diminishing auditory skills involve the complex processes of receiving, storing, and interpreting acoustical input information; deficiencies in these processes combined with retrieval difficulties constitute severe constraints on social communication.

Robber Sekuler "Vision as a source of simple and reliable markers for aging" pp220-227.

* pupillary and lenticular changes

Sample -> 121 Volunteers aged 21-81

Collaborated with US Air Force Aerospace Medical Research Lab.

Test: Pupillometer card. Pupil diameter decrease with age.

Significant correlation. Acuity: ability to resolve fine

details. Most older people have some degree and kind of cataract.

p. 225 Age markers chosen from changes in vision and the eye with age. Selection criteria included simplicity and reliability of measurement. Difficulties with some potential markers were considered, notably in accommodative amplitude and visual acuity. Candidates that seem promising are pupil diameter contrast sensitivity assessed with large targets, and amplitude of accommodation. Although no such work has been done previously, coordinated measurements of these candidate age markers might repay the effort. From what we know of each separately, they seem to track age in somewhat different ways. Very likely if we had all 3 measures on a large number of subjects, it might be possible to combine the three into a single multi-variate statistics that not only would be easy and cheap to capture but also could provide a powerful marker of biological aging.

John D. States "Musculo-skeletal system Impairment Related to Safety and Comfort of Drivers 55+" p63-76

*Physiologic changes occur in the musculo-skeletal system and in part account for the increase in accident and injury-severity rates for drivers 55+.

* Degenerative arthritis of the spine and major joints is the

most common source of such impairment. Bony and ligamentous joint injuries leading to degenerative arthritis, and muscle weakness and tightness of aging process also produces impairment of driving.

*Power steering, power brakes, and power seats and special adaptive devices will permit driving by patients with major musculo-skeletal-system impairments.

*Double shoulder-strap systems to reduce injury chest and abdomen.

* Seat design is intimately related to safety and comfort. Lower seat-cushion design will prevent submarining of the pelvis from beneath the lap belt and will prevent injury of the soft-tissue contents of the abdomen. Increased stiffness of the lumbar area of the seat back and lateral chest support will significantly reduce fatigue and increase comfort of the motorist's seat.

* Kneebars and seats designed to prevent submarining

*Proper use of current seat belts -- improper use: the shoulder under the arm and/or the lap belt over the soft part of the abdomen.

Darlene J. Winter "Learning and Motivational Characteristics of Older People Pertaining to traffic safety" p77-86

p84: In conclusion, this paper reviewed learning and motivational characteristics of older drivers and discussed the importance of targeting the growing group for training and retraining courses planned with their characteristics in mind. It also sought to bring attention to ways in which normal aging characteristics influence one's ability to interact with the total traffic environment -- signs, signals, lights, markings, roadways, and other communication vital to traffic safety. Certainly, all of those involved in the field of transportation, from licensing agencies to highway planners, to vehicle designers, and manufacturers, share the responsibility of researching their domains and making necessary changes to help accommodate these characteristics of elderly drivers and consequently making driving safer for all age groups.

Mark Freedman, Paul S. Davit, Lorin K. Staplin, Michael E. Breton 1985 Traffic signal brightness: An Examination of

nighttime dimming Report no. FHWA/RD-85/005 Federal Highway Administration Washington, DC.

Abstract: This report documents the procedures and findings of a study to determine the traffic operation, safety, and economic impacts of dimming traffic signals at night. A laboratory experiment was conducted to measure how quickly and accurately elderly and color-deficient drivers responded to signals dimmed to as low as 12.5% of ITE recommendations. Controlled field experiments evaluated driver responses to 8 inch and 12 inch signals dimmed to as low as 10% of ITE recommendations, seen against simple, moderate and complex backgrounds. Observational field studies confirmed that drivers behaved safely and effectively when signals were dimmed to as low as 30% of ITE recommendations. Economic analysis indicated that simple dimming arrangements can repay the initial investment in 3 years and save about 10% in energy.

Improving Transportation Services for Older Americans, Volume 1:
General Report Sept. 1980, US Dept. of Health and Human Services. US DOT. Administration on Aging, Washington DC and DOT.

The study was based on an assessment of the experience, problems, and solutions of the local transportation providers serving older Americans and the data for the assessment was drawn directly from the providers and their funding agencies - - mainly the area agencies on aging. The study drew on the available literature, data collected from a phone survey and in-depth field interviews with a collected sample of providers. These sources served as the core for most of the information on which the findings and conclusions contained in this report are based.

Conclusions:

1. As the proportion of elderly people in the pop. is growing, the attractiveness of retirement communities appears to be an increasing trend.
2. On the basis of the life-style characteristics of the inhabitants of retirement communities, their travel behavior would appear to be uniquely different from that of the elderly groups previously described in the literature. Their propensity to travel would appear to be much higher, with a large portion of trips having destinations within the communities.
3. Sorting of housing into categories such as apartments,

extended care facilities, nursing homes, and single-family detached housing appears appropriate for improving travel demand estimation for the elderly population.

4. Birth date and description of dwelling unit type appear to have a high potential for use as independent variables in a life-style-based travel demand estimation model.

5. Existing travel demand models generally fail to incorporate the effects of aging beyond 65 years of age on travel demand and fail

Allen, R. Parseghian, Z., and van Valkenburgh, P. (1980). Age effects on symbol sign recognition. Report number FHWA/RD-80/126. Federal Highway Administration.

This study of symbolic road signs and effective use by elderly drivers on the highway looked into the problems encountered in learning and retaining the symbolic information using a driving simulator. They found strong age effects but no influence due to the type of symbol training used. The elderly had less symbol knowledge initially and needed longer recognition and response time. However, all subjects learned and retained approximately the same number of symbols.

Conclusions: Older drivers do not appear to have problems learning and retaining symbolic sign knowledge. Older drivers have less current symbol sign knowledge. Older drivers require more time to process symbol sign information. The training method did not influence the learning or retention of symbol knowledge. Training methods used were symbol and a plaque phrase, symbol and a pamphlet explaining each symbol, and the symbol and both plaque and pamphlet.

Huston, R. and Janke, M. (1986). Senior Driver Facts. Department of Motor Vehicles, Research and Development Section.

This document contained information on driving records of senior drivers and research results. It is intended to assist traffic safety administrators in making decisions and for the insurance industry also. In general, elderly drivers show an under-involvement in accidents. They are relatively low risk, but higher risks in accidents per miles driven. Authors feel there is a need to improve licensing and testing procedures to identify visual impairments and other health problems commonly found with the elderly. Also contained in this document are many statistics on the number of elderly in CA and the number of licensed drivers. Results found include: accidents involved in per 100,000 miles drops after age 18-19 until 50-

54 where it levels off. Then it increases at 55-59 and more sharply at age 65-69 and again at 70-74. The number of driving convictions is relatively flat for all ages, with a small increase at age 70-74. Most elderly drivers have vision restrictions and they compensate for impairments by: driving slower, driving less, and driving only in good conditions.

Winter, D., Malfetti, J., and Schwendiman, F. (1988). Older Drivers in the United States and Canada. Columbia University.

This document predicted that in the year 2000, 1 in 3 drivers will be over age 55. Currently this number is 1 in 5. Authors find that driver skills begin to deteriorate at age 55 and dramatically so after age 75. Many DMV agencies claim they lack data and guidance on what to do about older drivers. Some agencies feel however, that current data does not reflect any problems. This may be because of the data not being recorded by age or age group. Many agencies use age to determine how often to re-examine and what type of testing to do. They feel vision testing needs to be more comprehensive, including testing of night vision, depth perception, and peripheral vision. DMVs want good, quick, easy, and reliable tests to measure these. They also feel training is needed for DMV personnel to help them spot applicants that might need

further examination. Finally, they feel mandatory reporting by physicians is warranted.

P.A. Brain. (1980). Safety and Mobility Issues in Licensing and Education of Older Drivers. Report number: 7-01582. NHTSA, U.S. Department of Transportation.

This study also concentrates on driver licensing procedures.

Major conclusions found regarding elderly drivers include:

- * More older people are continuing to drive and retaining their driver's licenses than ever before and they will continue to increase.
- * More elderly men drive than women, but more women than before are continuing to drive.
- * Elderly drivers avoid driving at night, in rush hour, and in winter.
- * Men somewhat curtail their driving at age 60; women at age 65.
- * The number of accidents doesn't increase for the elderly, but the number of accidents per miles driven does for those over 65.

- * When in an accident, those over 64 are more likely to be injured or killed.
- * Failure to yield right of way is a major contributing cause of older driver accidents.
- * Failure to obey signs and signals increases at age 65 and greatly increases at age 74.
- * Turns at intersections (especially left turns) are major causes of accidents for the elderly.
- * Inattention is also often the cause of elderly driver accidents.
- * Medical impairments are often a factor in accidents.
- * The driver education programs have not demonstrated their effectiveness.
- * Few states use age criteria for license re-examinations.

Authors find that driver improvement should be the focus of future programs, not driver testing. They suggest two programs: A guide for experienced drivers over age 55, and a model of older driver licensing and improvement system.

The guide contains these things:

- * Drinking and driving
- * Looking ahead, to the sides and behind, vision problems, and seeing at night
- * Giving warning and using lights

- * Slowing down unexpectedly, when to signal, false signals
- * Yielding the right of way, stop signs, traffic lights, and yield signs
- * Turning at intersections -- left and right
- * Highway driving, speed, safety, rules of the road, physical limitations, and parking, braking, and emergencies.

The model includes a series of tests and driver improvement activities. These activities whether to issue, restrict, or deny a license. The procedures include medical screening and evaluation, knowledge test, vision test, in-car performance test, and a driver history review.

Barakat, S., and Mulinazzi, T. (1987). " Elderly Drivers: Problems and Needs for Research". Transportation Quarterly, 41, 189-206.

This document was mostly a literature review and contained some research areas and conclusions about elderly drivers:

- 1) The majority of older people are not senile. There is little or no decline with age in short term memory storage capacity. There is little increase in the number of persons that can't remember things in long term memory, so the

majority of aged don't have serious memory defects.

- 2) There is a decline in the functioning of all five senses.
- 3) Physical strength decreases with age.
- 4) Older persons are able to adapt to the major events and changes required in their lives.
- 5) It takes longer to learn something.
- 6) Older persons have slower reaction time.

A workshop quoted concluded that:

- * Aging impairs the driving skills required such as vision, alertness, risk-evaluation, and decision-making.
- * Society need to be able to identify high-risk drivers and define more precisely impaired drivers.

Too little is known about discrete performance skills and abilities and their relationship to safe driving. For example, we know good vision is critical to safe driving, but what specific visual criteria should be applied in licensing drivers. Elderly are particularly sensitive to glare, dark adaptation, diminished coordination, and slow reaction time. Age is not a valid criteria because of the variability in capabilities. Elderly drivers seem very receptive to retraining to update their skills and knowledge. There are low usage rates on elderly in seat belts. There is a need for more and deeper research into elderly driving performance and the conditions that influence it. Many elderly have

difficulty seeing , interpreting, and responding to many traffic control devices. The complexity of highway transport systems warrants data and analysis on highway safety and age factors.

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