Communication Interface and the Older Driver

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Scope of Today’s Talk

● Will focus exclusively on performance/usability issues (human factors) of older vs. younger drivers using communication and navigation devices inside the vehicle

● Will NOT focus on:
  ● Any particular cars or communication/navigation devices
  ● General driving performance of older vs. younger drivers
  ● Traffic safety issues
  ● Older driver highway design
  ● Preferences, or likes and dislikes, of older vs. younger drivers
  ● Needs and wants of younger vs. older drivers
Background

- The ‘mature’ market is important to the success of any vehicle manufacturer.
- The customer base is often heavily weighted with mature owners.
- The ‘babyboom’ generation represents a growth segment of the market over the coming decades.
- As the ‘boomer’ generation exceeds 50 (in age, not speed!), its members are likely to become increasingly sensitive to the age-related needs of today’s mature owners with respect to vehicle interiors; e.g., more legible instrument panels.
- In general, customer satisfaction among ‘mature’ owners will be critical to the success of any vehicle manufacturer.

Aging of Baby Boomers

Population vs. Age and Year

Source: US Census
Demographic studies reveal that the number of people in the U.S.A. between ages 55 and 74 will almost double by 2030 from 40 to 74 million.

In Europe, projected figures for the period 1985 to 2005 show the number of male drivers older than 65 increasing by 90% and the number of female drivers in that age group rising by some 200%.

Source: Automotive Engineering International/ May 1999, p. 60

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Definition of Mature Customer

- Age to separate ‘young’ and ‘mature’ customers?
- Age effects progressive, no quantifiable threshold exists
  - Large individual differences in changes associated with aging
  - Many of these changes can occur at different rates in different individuals
- Declines associated with normal aging
  - But effects of some age changes may be compensated through skills/knowledge which grow rather than decline: e.g., slower reaction times may be offset by increased caution and vigilance or slower driving speeds
- For purposes of today’s focus, less than age 50 defined as younger, greater than or equal to 50 defined as older
Age-Related Changes - Vision

- Decreased ability to focus on near objects – 45 (Presbyopia)
- Reduced sensitivity to contrast - 50
- Reduced ability to resolve details in stationary objects
- Reduced sensitivity to light
- Reduced sensitivity to seeing detail in moving objects - 45
- Increased sensitivity to glare - late 40's to early 50's.
- Reduced range of color vision
- Dark and light adaptation
- Subclinical retinal degeneration –40
- Reduction in the visual field
- Reduction in the useful field of view
- Reduction in temporal visual sensitivity
- Depth perception
- Visual persistence
- Separating figure from ground, visual distractions
- Cataracts > 60

Age-Related Changes - Vision (2)

- In general, research has found it difficult to directly relate these physiological visual changes with driving performance of older drivers, with a few exceptions:
  - Cataracts - Older drivers with cataract were 2x more likely to report reductions in days driven and number of destinations per week, driving slower, and preferring someone else to drive. [Owsley et al. (1999), J. of Gerontology: MEDICAL SCIENCES, 1999. Vol. 54A, No. 4, pp. 203-211].
Vision (3): Presbyopia Example

In a 1991 vehicle, this 71 year-old, presbyopic woman puts on her reading glasses and leans forward, saying, "This is what I have to do to make out the speedometer numbers. Usually I do not have to wear glasses when driving. I could not drive this car."

In other words, without her reading glasses she can see well outside but not inside the vehicle, and with her glasses she can see well inside but not outside the vehicle. Bifocals might help in such a situation, if she chose to wear them, and/or larger speedometer numbers.

Vision (4): Contrast Example

Graphics on climate control exhibit poor color and brightness contrast when exposed to sunlight, making them difficult to read, particularly for drivers with low contrast sensitivity.
**Age-Related Changes - Other Sensory**

- **Balance and Spatial Orientation**
- **Audition**
  - Decreased ability to hear at normal volume
  - Speech Comprehension
  - Decreased ability to localize sounds
- **Tactile Sense**
  - Decreased Sensitivity

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**Age-Related Changes - Cognition**

- Speed of Information Processing
- Attention
- Problem Solving, Decision Making, and Intelligence
- Learning and Memory:

  Example: Kostyniuk et al. (1997) found that analysis of the experimental data showed differences in the way the oldest group, that is, drivers over 64 years of age, used the navigation systems:

  - Had more problems learning and understanding the navigation systems
  - Had greater difficulty programming the destinations (for Ali-Scout)

  However, once learned, older drivers tended to use it more than younger drivers.

Kostyniuk, L. P., Streff, F. M. and Eby, D.W. The older driver and navigation assistance systems, Univ. of Michigan Transportation Research Institute, UMTRI-90423, Nov. 1997
Age-Related Changes - Motor Responses

- Strength, Endurance Stamina, Flexibility, and Dexterity
- Motor Movements
- Psychomotor Changes - 50
  - (But reaction times of young and old are equal when verbal response required)
- Anthropometry (Body's size, weight and proportions)

General Vehicle Interior Issues for Mature Owners

- Seat belt convenience and ease of use
- Door handle convenience
- Glovebox, ashtray, & console convenience
- Controls convenience
- Front/Rear entry/exit ease
- Front head room
- Front leg room
- Ride smoothness
- Outside noise absence
- Wind noise absence
- Instrument legibility
**Communication Issues**

- Communication in the vehicle is done as an additional task “on top of” the primary driving tasks
- It’s not enough to ensure that communication tasks are easy to do; they must be successfully integrated with the primary driving tasks
- For mature drivers, the challenge of user interface design:
  - meet the needs of mature individuals for communication,
  - at the same time, make sure that needs/requirements in the primary driving tasks are met.

**Communication Issues: Motivation for Today’s Focus**

- New devices coming into the vehicle in the next decade allow for increased communication and navigation capabilities for the driver
- These are of particular benefit for the mature driver
- Examine factors that characterize the mature driver, to optimize their performance with the system
- Working hypothesis: Making things work well for the mature driver should also make them work well for younger driver, in most instances
Current Communication/Navigation Systems in U.S.

<table>
<thead>
<tr>
<th>Type</th>
<th>Devices</th>
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<tbody>
<tr>
<td>ADT Mobile Security Network</td>
<td></td>
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<tr>
<td>Alpine Mobile Mayday</td>
<td></td>
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<tr>
<td>ATX On-Guard Tracker</td>
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<tr>
<td>Audiovox GPS</td>
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<tr>
<td>Auto PC by Clarion</td>
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<tr>
<td>BMW Mayday Telephone</td>
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<tr>
<td>Bosch Travelpilot</td>
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<tr>
<td>Portable:</td>
<td>Palm Pilot, Portico, Wildfire, PC Based System</td>
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</tbody>
</table>

Plus many future concept cars show such devices (following slides)

Future Example 1 - Cadillac Evoq

Future Example 2 - Mercedes-Benz SLR

Mercedes-Benz Vision SLR concept car (above) - note central high-mount navigation display, which also integrates radio, CD player, and TV onto a single color screen.

Note display closes when driver leaves car (above).


Future Example 3 - Opel Concept A

Opel Concept A microvan - note central pop-up screen for satellite-supported navigation system, and digital instruments.

Source: Automotive Engineering International, May 1999, p. 58
Future Example 4 - Lear Trans G

Concept Interior
- Designed for Mature Driver
- Ease of Entry and Egress

(Note navigation screen)

- front seat powered rotation to 45 degrees
- lower stepup height and flat floor
- instrument pod moves toward driver instead of moving seat fore and aft

Source: Automotive Engineering Intl, May/99, p. 59
Future Example 4 - Lear Trans G (3)

- Display
  - Large letters in cluster

- Controls
  - Controls simple, uncluttered, formatted according to usage, frequency, sequence of use, and function
  - Minimize reach by keeping all controls within a zone of elbow to fingertips
  - Provide large buttons and levers, adequate hand clearance, and ease of effort

- Other
  - adjustable pedals
  - eliminate background noise and use louder low frequencies

Potential Controls and Displays Issues for Mature Driver

- Locating controls and displays
- Legibility of controls and displays
- Comprehending controls and displays
- Reaching and adjusting controls and displays
- Hearing Auditory Stimuli
- Noise and communication
Illustrative Research Results on Older Drivers

Age and Device Effects on ‘Trial Time’ for in-vehicle communication and navigation devices (Tijerina, IHRA/ITS Workshop, 1999)

Note that for all navigation devices tested, whether young and old, trial time was substantially longer than for cell phone or radio tasks.

Illustrative Research Results on Older Drivers (2)

Reaction time to automotive test display increases as a function of age

Performance on several common measures gets slightly worse on instrument panel tasks for those over 50 compared to those under 50


Some Illustrative Recent Research Results

- Results taken from a study that looked at driver’s ability to use new communication and navigation technologies
- Inclusion of demographic variables of age and gender allowed these variables to be examined
- Are any effects found which were not in line with previous research?
- That is, were there any age-related changes which are specific to new communication and navigation devices?
Overview Of Method

- Research participants were selected randomly from mid-size vehicle owners in the Detroit area, with balance for gender and age
- Research participants tested in stationary vehicles
- Performed communication and navigation tasks under simulated driving conditions intended to mimic driving-like workload
- However previous work evaluating driver performance in simulation indicates that on average workload is somewhat less than in actual driving
- Anchor tasks (ordinary in-vehicle tasks) performed as controls for this difference

Procedure

- Give prior instruction (storyboards with instructor, on tasks to be performed)
- Sit in vehicle, adjust seating position
- Watch roadway scene on video monitor in front of car
- Monitor the scene for the appearance (at random times) of a red light, and immediately step on the brake
  - Simulates brakelight coming on in front of them, creating some visual demand that required constant observation and response to the forward roadway
- Perform (upon commands from the experimenter) three ordinary in-vehicle ‘anchor’ tasks: Adjust mirror, Adjust vents, Set cruise control
- Perform (upon commands from the experimenter) two tasks using the vehicle’s infotainment system:
  - Navigate to school
  - Call your daughter
- A practice trial on each infotainment task was given prior to data collection
Subject Sample and Experimental Design

- 94 research participants
- Age: Half under 50 years, half over 50
  - No one over 65
- Gender: 45% male, 55% female
- All experimental conditions were tested in a within-subjects experimental design (order of conditions was fully counterbalanced)

Experimental Set-Up

- Vehicles electrically powered but stationary during experiment
- Video monitor in front of vehicle played a continuous loop of a videotaped driving scene
- Small red L.E.D. light centered at lower edge of monitor turned on at random times (to mimic a braking vehicle in front of the test vehicle)
- The brake system of the test vehicle was wired such that an application of the brake pedal turned off the L.E.D. light and recorded a response time to the data file
- Three tiny video cameras were mounted inside the vehicle and images were recorded (multiplexed and time-synchronized into a single image for each frame)
  - One camera focused on the participants face (to record glances)
  - One camera focused on the participants’ hands (to record hands-off-wheel and on-device behavior)
  - One focused on the forward scene to show brakelight illumination
- The words ‘Hood’ and ‘Brake’ to indicate the brakelight and brake events were recorded on the video, for illustrative purposes.
- A microphone was mounted on the vehicle interior to pick up vocalizations of participants (which were recorded on videotape)
- Systems included error recovery paths, but subjects were not specifically trained on them.
Measures of Performance Reported Here

- In-Vehicle Communication and Navigation Measures
  - Task completion time (secs)
- Simulated ‘Crash Avoidance’ Related Measures
  - Response time (secs) to simulated brake light
  - Mean subjective rating of situation awareness
    “How aware were you of surrounding traffic when you were performing the secondary task.” (1 = low, 100 = high)
- Workload Measures
  - Mean subjective workload rating (3 averaged ratings)
    Example: “How much mental and perceptual activity was required.”
    (1 = Easy, 100 = Hard)

Driver Set Up
Data Recording Display: Navigation System

Voice Recognition Communication System
Seven Video Examples

1. Experimental set-up
   Task: Find school using touch screen navigation system:
   2. Successful (younger woman)
   3. Unsuccessful (older woman)
   Task: Find school using toggle control navigation system:
   4. Successful (older woman)
   5. Unsuccessful (younger woman)
   Task: Call daughter using phone voice recognition system:
   6. Successful (younger man)
   7. Unsuccessful (older woman)

Task Time vs. Age

Older drivers took slightly longer (4.5 secs., 12%) to complete the communication and navigation tasks than did the younger drivers.

ANOVA p = 0.0261
**Response Time vs. Age**

Older drivers took slightly longer (0.1 sec., 6%) to respond to a simulated forward event than did younger drivers during communication and navigation tasks.

![Response Time vs. Age Graph]

**Workload vs. Age**

Older drivers had a slightly higher subjective workload (3 points, 7%) than did younger drivers during the communication and navigation tasks tested.

![Workload vs. Age Graph]
**Situation Awareness vs. Age**

Older drivers had a slightly lower subjective outside vehicle situation awareness (2 points, -7%) than did the younger drivers during the tasks tested.

![Bar chart showing situation awareness vs. age with ANOVA p < 0.0001](chart1)

**Awareness vs. Age Effect is Gender Dependent**

The reduced situation awareness of older drivers on the previous slide was due entirely to males (6 points, 9%); females showed no decline in subjective situation awareness with age.

![Bar chart showing awareness vs. age with gender effect](chart2)

ANOVA:
- Gender: p<0.0001
- Age x Gender: p = 0.0001
Unsuccessful Trials vs. Age and Interface

Older drivers had more unsuccessful trials than younger drivers; but the differences between user interfaces (T vs. S or R) were far larger than the differences between younger and older (white vs. dark bars).

Discussion

- Although older drivers showed some deficits relative to younger drivers, the size of these effects was small, and in line with previous studies on the size of differences between younger and older drivers for in-car tasks.
- There is thus no reason based on age alone, why newer types of navigation and communication aids should or should not be used by older drivers, relative to younger drivers.
- A more critical factor is the usability of the user interface, for both younger and older drivers alike.
Conclusions 1

- The examples confirm previous research results that on average, older drivers compared to younger drivers show slight deficits in performance on in-vehicle communication and navigation tasks.

- These differences between younger and older drivers for communication and navigation tasks are in line with previous data finding such age-related differences in conventional in-vehicle driving tasks.

Conclusions 2

- That is, the slight relative deficits with age that are found when older drivers use communication and navigation devices in the vehicle, are the same relative deficits as are found with other devices in the vehicle.

- In conclusion, based on performance issues, older drivers should not be dissuaded from using (or persuaded to use) the new communication and navigation systems coming into vehicles, anymore than should younger drivers.
Conclusions 3

- Furthermore, the differences between younger and older drivers are small compared to the differences arising from different user interface designs. That is, a poor user interface design that is too complex will cause both younger and older drivers to perform poorly, and a good user interface device will cause both to perform well, in general.

- It is recommended that human factors testing and expert human factors knowledge should always be applied during the human interface design of vehicle communication and navigation systems, to ensure that they are easy to use for all drivers, not just older drivers.

Closing Observations

- In general, there is much data in the literature that can be used to develop specific requirements for vehicles targeted at mature segments of the market.

- Additional investigation is required to fully characterize the human factors problems associated with aging, and specify the detailed vehicle requirements necessary to address those problems.

- Many of the problems associated with older drivers using advanced communication and navigation systems are also found with younger drivers, and can be primarily attributed to differences in the usability of the user interface.

- User interface requirements are critical in general for both younger and older drivers for using communication and navigation systems in a vehicle.

- Efforts and resources should be placed into developing easier-to-use user interfaces for advanced communication and navigational situations for in-vehicle use, that would benefit both older and younger drivers alike.

“This research highlights the need to have better navigational support for drivers, particularly elderly drivers. Improved road signs and in-vehicle navigation aids are two solutions that might help enhance the mobility of elderly drivers.”