Age-Differences in the Visual Information Processing Demands of Vehicle Instrument Panel Interfaces

Frank Schieber
Ann Holtz
Jason Myers

Heimstra Laboratories
University of South Dakota
Preliminary Results of a Driving Simulation Study
The Nature of the Driving Environment is Changing

- More sophisticated instrument panels will impose increased demands upon driver attentional resources

- Aging of the driving population (with age-related reductions in attention)
• Head-up displays
• In-vehicle traffic signs/warnings
• ATIS interactive displays
• Internet console

Advanced Instrument Panel Development
Wireless Applications
Protocol Browser

Experimental
Text Messaging
Console
Research Questions

• What are the visual demands imposed by in-vehicle text display consoles?

• How do these demands vary with aging?
Experimental Design

- **Age**
  Young (20-25) vs. older (67-82) drivers

- **Message Length**
  Read in-vehicle text messages of variable length (6 levels: 1, 2, 3, 4, 6 & 8 lines)

- **Roadway Condition**
  4 levels of geometry: straight; work zone; sharp curve; and, passing zone/maneuver
Visual Demand Proxy Measures

• **Driving Performance Decrement**
  - Crashes
  - Speed variability
  - Steering variability

• **Eye movement patterns**
  - Eyes-off-road time
  - Glance frequency/duration
STISIM Driving Simulator (v. 8.0)

Special thanks to the 3M Company for the STISIM system.
Text Message Console

8-Line Text Display

Display Height: 7.5 cm 2.95 in
Letter Height: 0.5 cm 0.2 in 34 minarc
Viewing Distance: 46-56 cm 18-22 in

Video Camera
Response Keyboard

Display Width
10.4 cm (4.1 in)
Sample 4-Line Text Dialog
(24 point Times-Roman font)

If you were traveling on Interstate 29 from Beresford to Elk Point, you would be headed in what direction?

1) North
2) South

Message Screen

Response Screen
Simulated Driving Course

1. Straight segment #1
2. Work Zone
3. Straight segment #2
4. Curve
5. Straight Segment #3
6. Passing Zone

Course length = 2.8 miles (4.5 km)
2 practice laps
8 experimental laps
Impact of Reading Text upon Simulated Driving Performance

Dependent Measures

• Crashes
• Steering instability (lane position variability)
Crashes - Young Drivers

24 opportunities to crash while reading a message (4 highway complexity conditions x 6 message lengths)

Some crashes were observed!!!

2 percent crash rate across 384 experimental trials. (less than 1 crash per participant)
## Crashes - Older Drivers

46.8% crash rate while reading text messages

<table>
<thead>
<tr>
<th>Crash Rate (%)</th>
<th>Highway Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Straight Roadway</td>
</tr>
<tr>
<td>42</td>
<td>Sharp Curve</td>
</tr>
<tr>
<td>46</td>
<td>Passing Maneuver</td>
</tr>
<tr>
<td>75</td>
<td>Work Zone (narrow lane)</td>
</tr>
</tbody>
</table>
Steering Instability

• Lane position error increases with driver age
• Lane position error increases with message length
• Young Drivers
  1-2 lines = baseline; 3+ lines > baseline
• Older Drivers
  1 line = baseline; 2+ lines > baseline
Video Clips

Reading Text Messages on Straight Road Segments
Older Driver; Straight - Message Length = 1
Older Driver; Straight - Message Length = 2
Older Driver; Straight - Message Length = 3
Older Driver; Straight - Message Length = 4
More Video Clips

Reading Text Messages
Complex Roadway Conditions
Older Driver; Passing Maneuver - Message Length = 6
Young Driver; Passing Maneuver; Message Length = 8
Young Driver; Sharp Curve; Message Length = 6
Young Driver; Work Zone; Message Length = 3
Visual Demands of Text Displays
[Eye Glance Behavior]

- Total Glance Time required to read message
- Total Number of Glances
- Average Glance Duration
- Average Inter-Glance Interval***

{Button-press (final) glance deleted from all discussion of data}
Total Glance Time

Increases with message length

Rate of increase highest between 1-4 lines; slows thereafter

Age-related increase at message lengths greater than 2 lines
Number of Glances

- Mean Number of Glances increases with message length.
- No age difference for 1-2 line messages.
- Size of age difference increases as message length grows from 2 to 8.
Older drivers require longer off-road glances.

Glance duration per line increases from 1-4 but decreases thereafter (cost of text localization; redundancy at end of a long message).
Inter-Glance Interval
“Eyes-on-the-Road” Time

• Visual inspection of video tape records showed that older drivers required much greater “eyes-on-the-road” time between successive glances to the display screen.

• Total “real-time to respond” data clearly support an age-related increase in inter-glance interval.
Preliminary Conclusions

• Text messages longer than 2 lines intrude upon simulated driving performance

• On-road/off-road glance time ratio appears to be a promising measure of age differences in visual demand

• Closed-track study of age differences must precede proposed field-studies

• Practice-to-criterion stage needed for future simulation work (with STISIM v. 8.0)
Thank you.

Visit our web page for more information and work-in-progress.

http://www.usd.edu/~schieber