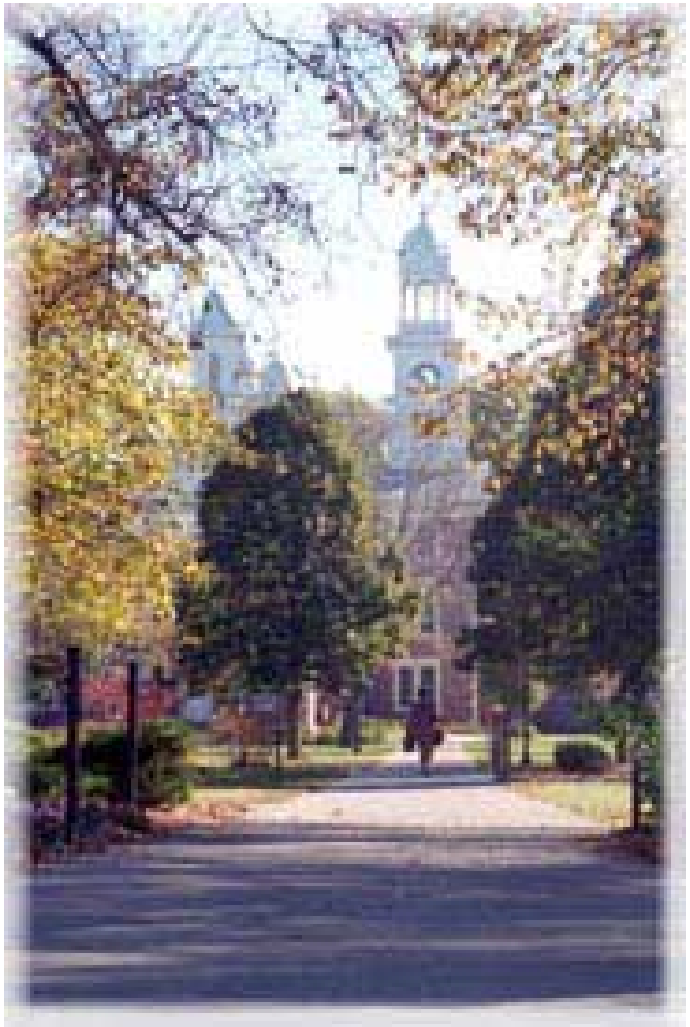

Analysis of the Visual Demands of In-Vehicle Text Displays Reveals an Age-Related Increase in the Time Needed to Reallocate Attention to the Road

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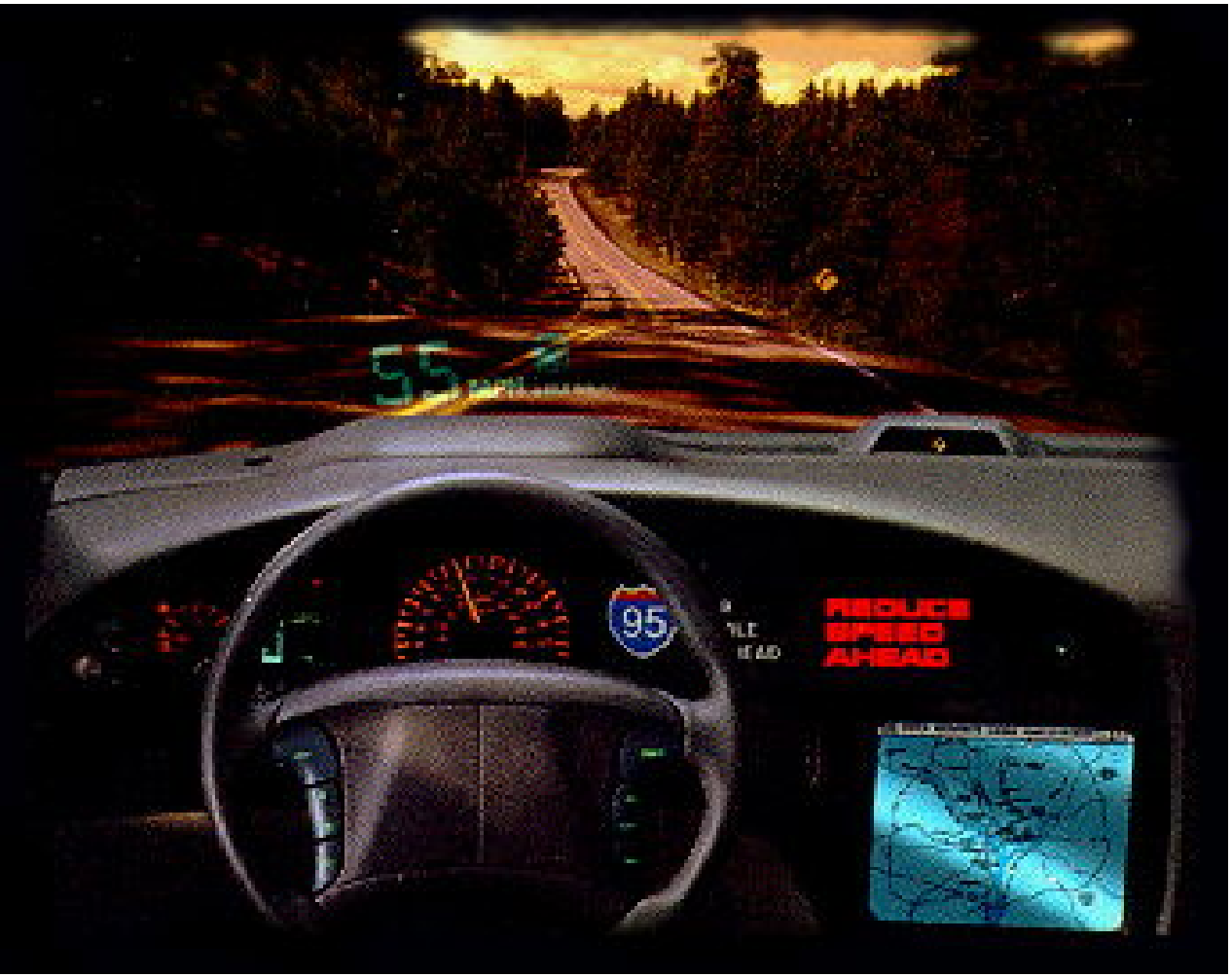
University of South Dakota

Frank Schieber, Ann Holtz,
Ben Schlorholtz & Robert McCall

The Nature of the Driving Environment Continues to Change

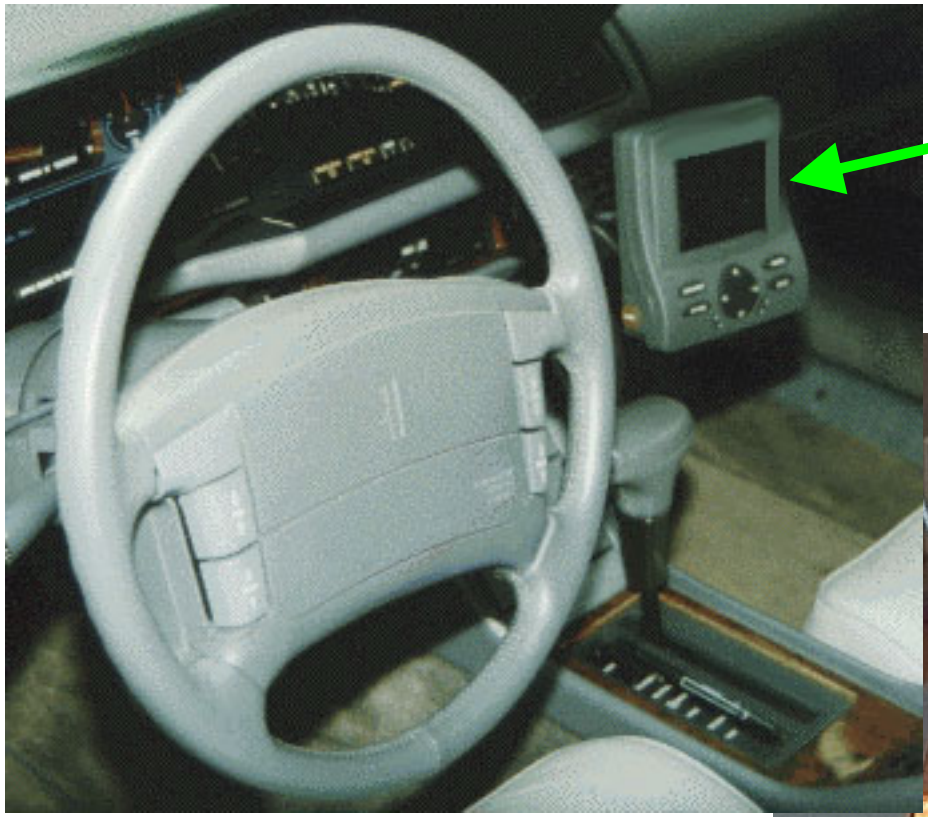
- Ever more sophisticated instrument panels will impose increased demands upon driver attentional resources

- Aging of the driving population (with age-related reductions in attention)

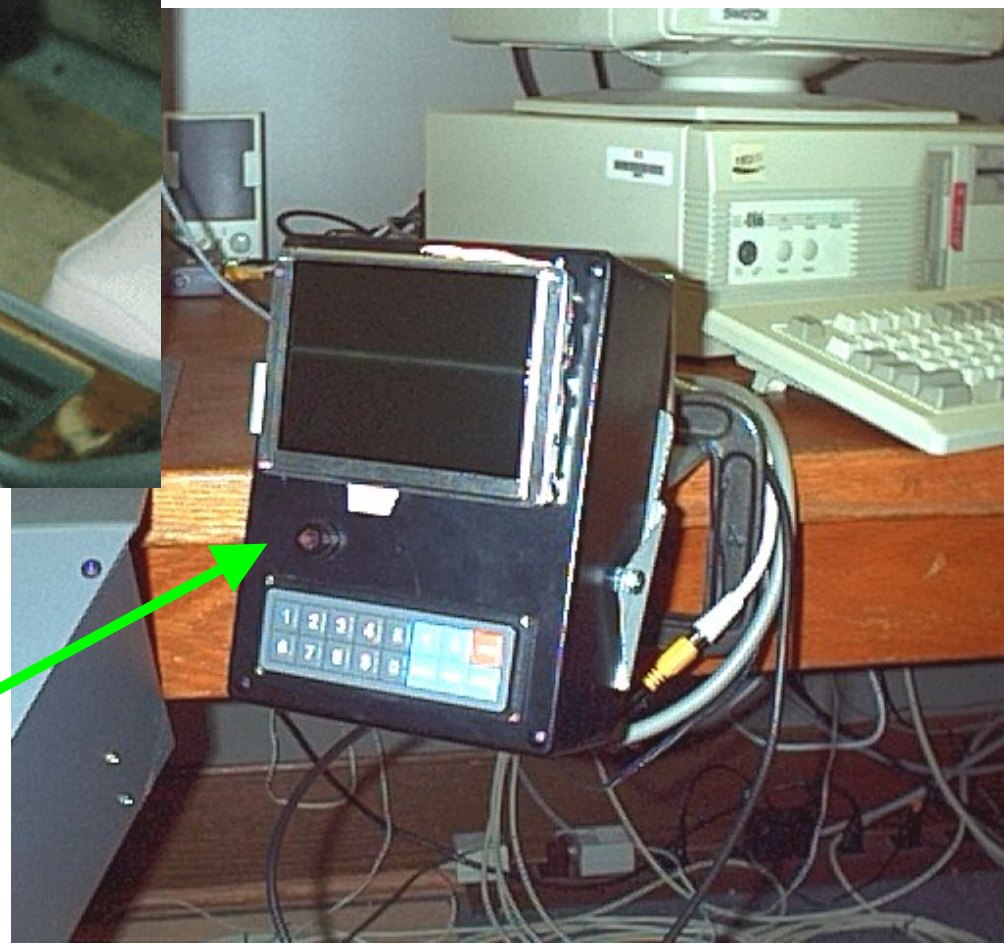


- Head-up displays
- In-vehicle traffic signs/warnings
- ATIS interactive displays
- Internet console

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?

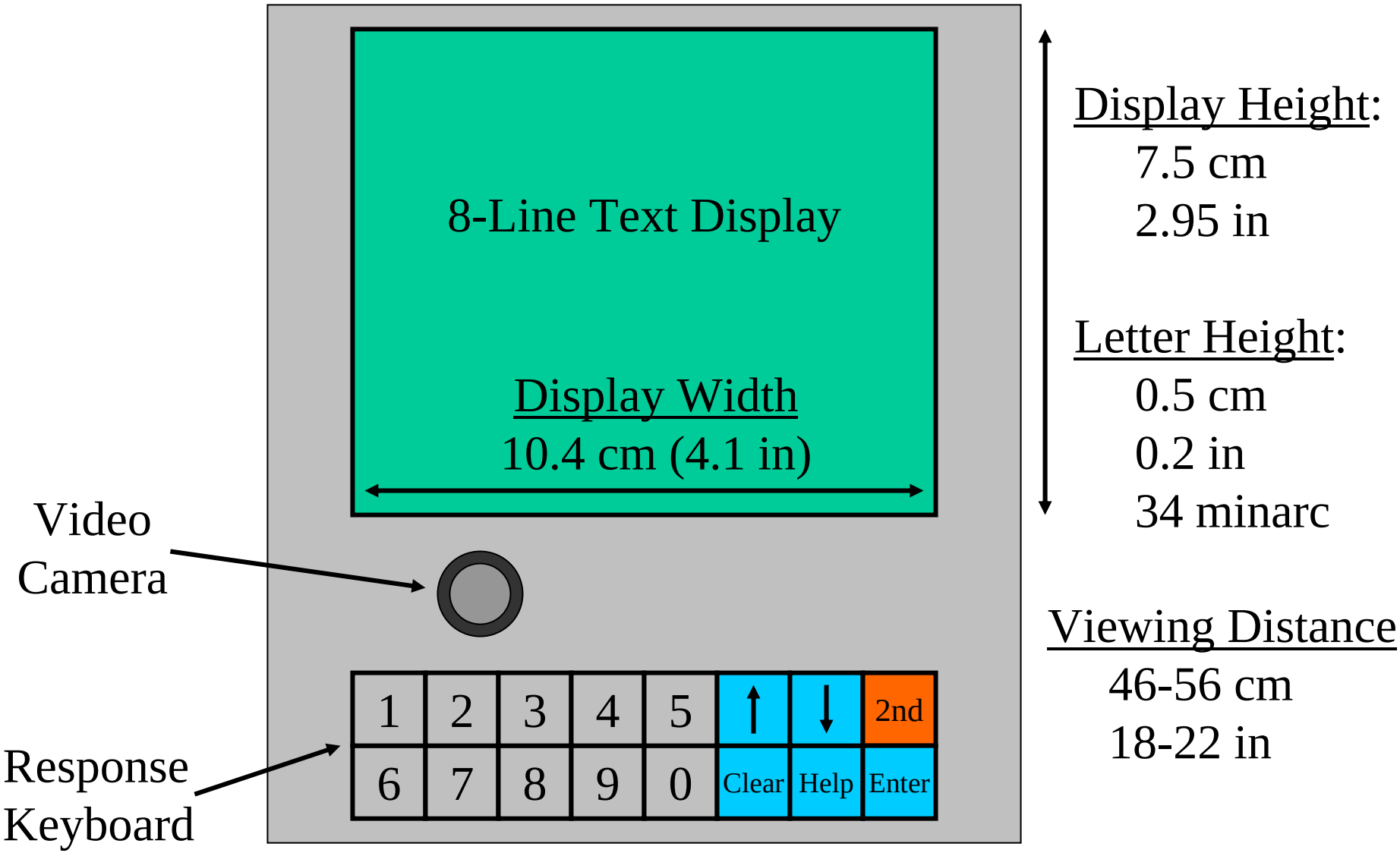
Can roadway gaze inertia previously demonstrated in older drivers be replicated? (re: Schieber, et al., 2000)

Experimental Design
(2) Age by (5) Message-Length

- Age
  Young (n=16; mean age=20; range=19-21)
  Old (n=16; mean age=77; range=65-85)
- Message Length
  Read in-vehicle text messages of variable length (5 levels: 1, 2, 3, 4 & 6 lines)
  (4 replications; plus 4 baseline control)

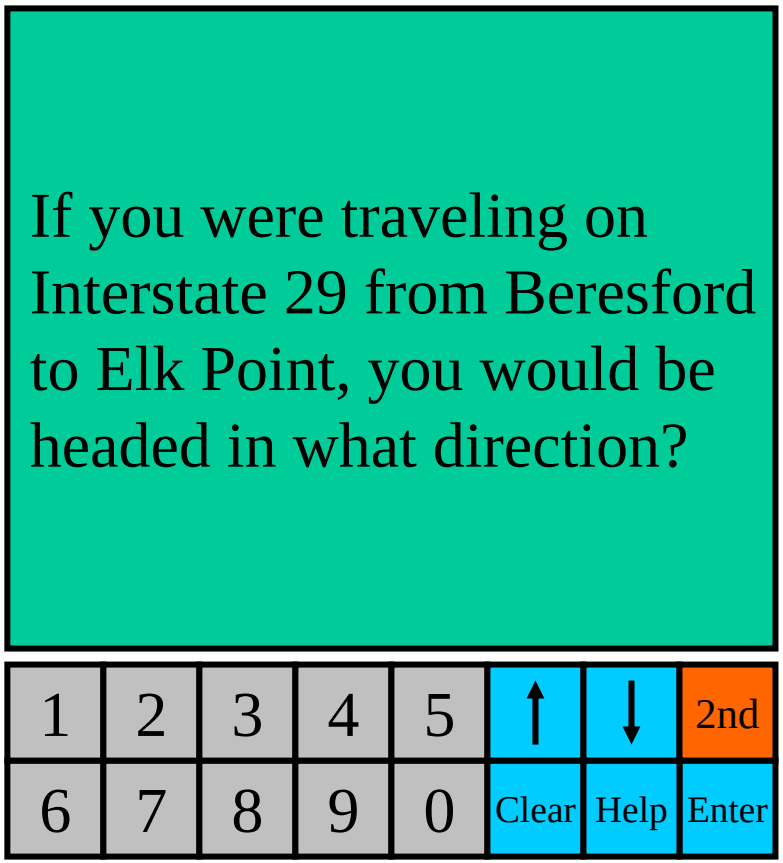
STISIM Driving Simulator (v. 8.0)

Text Message Console

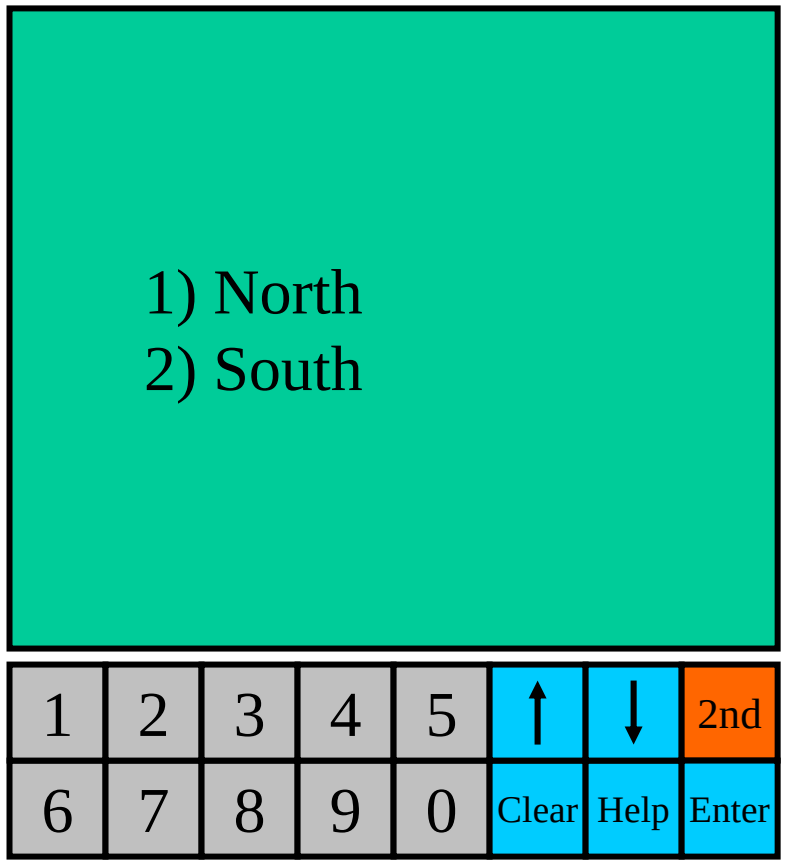


Sample 4-Line Text Dialog

(24 point Times-Roman font)

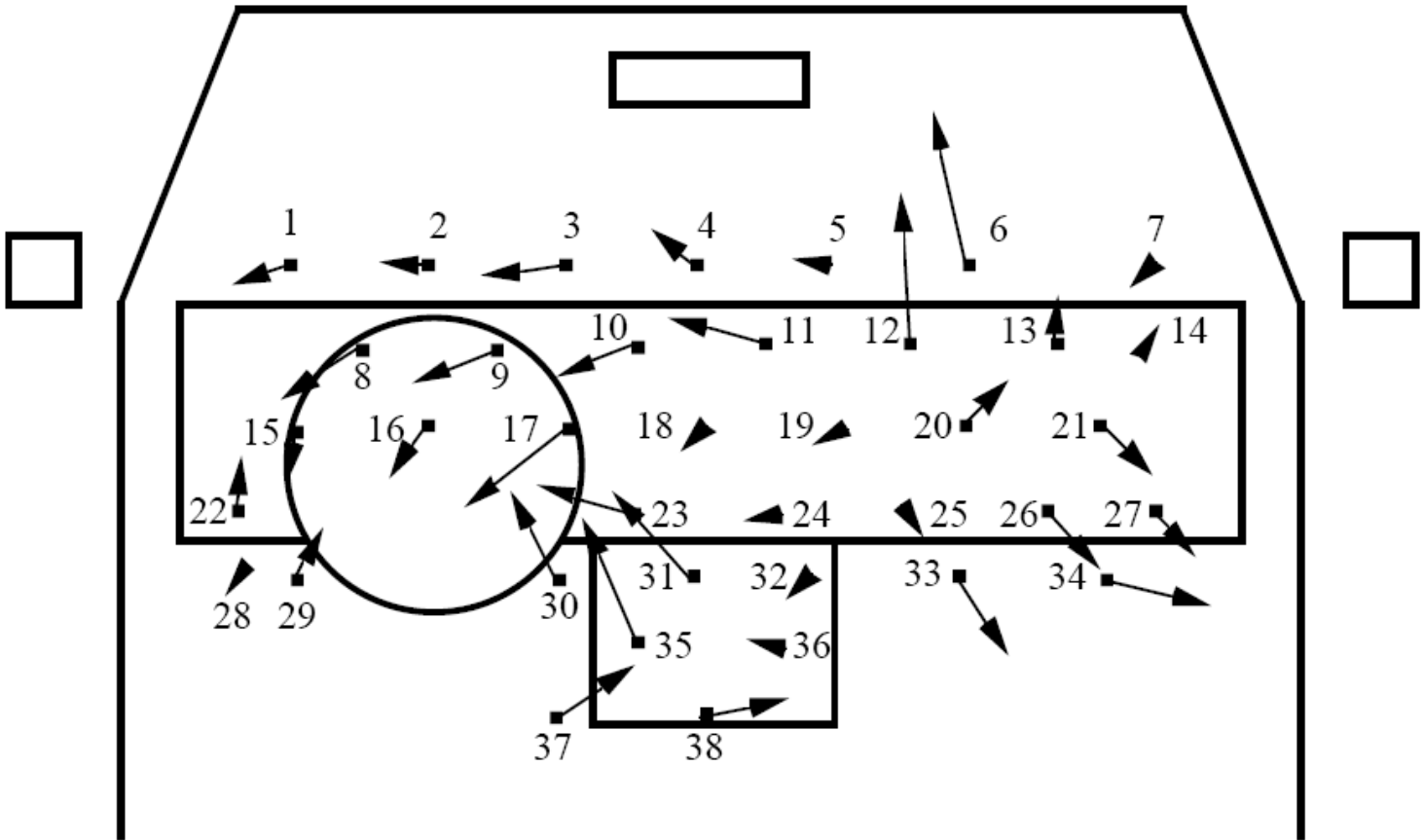


Message Screen



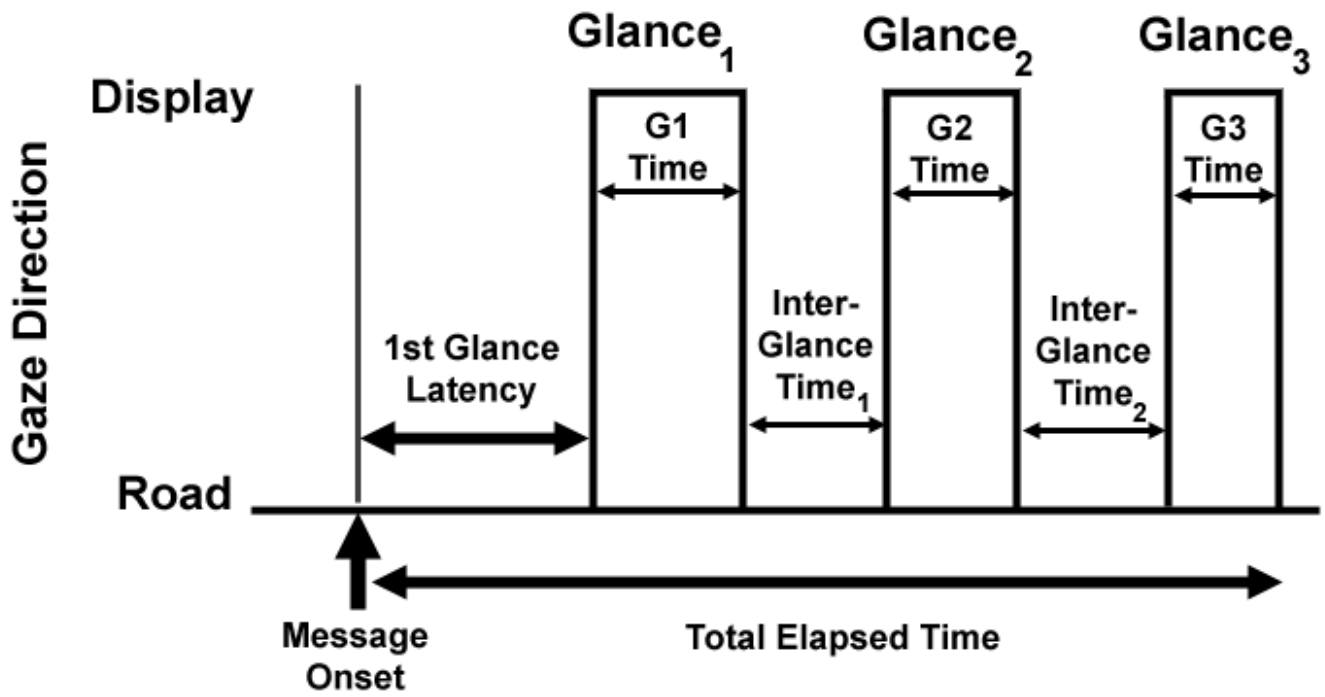
Response Screen

Video-based techniques are accurate enough to reliably discriminate eyes-on-display vs. eyes-on-road



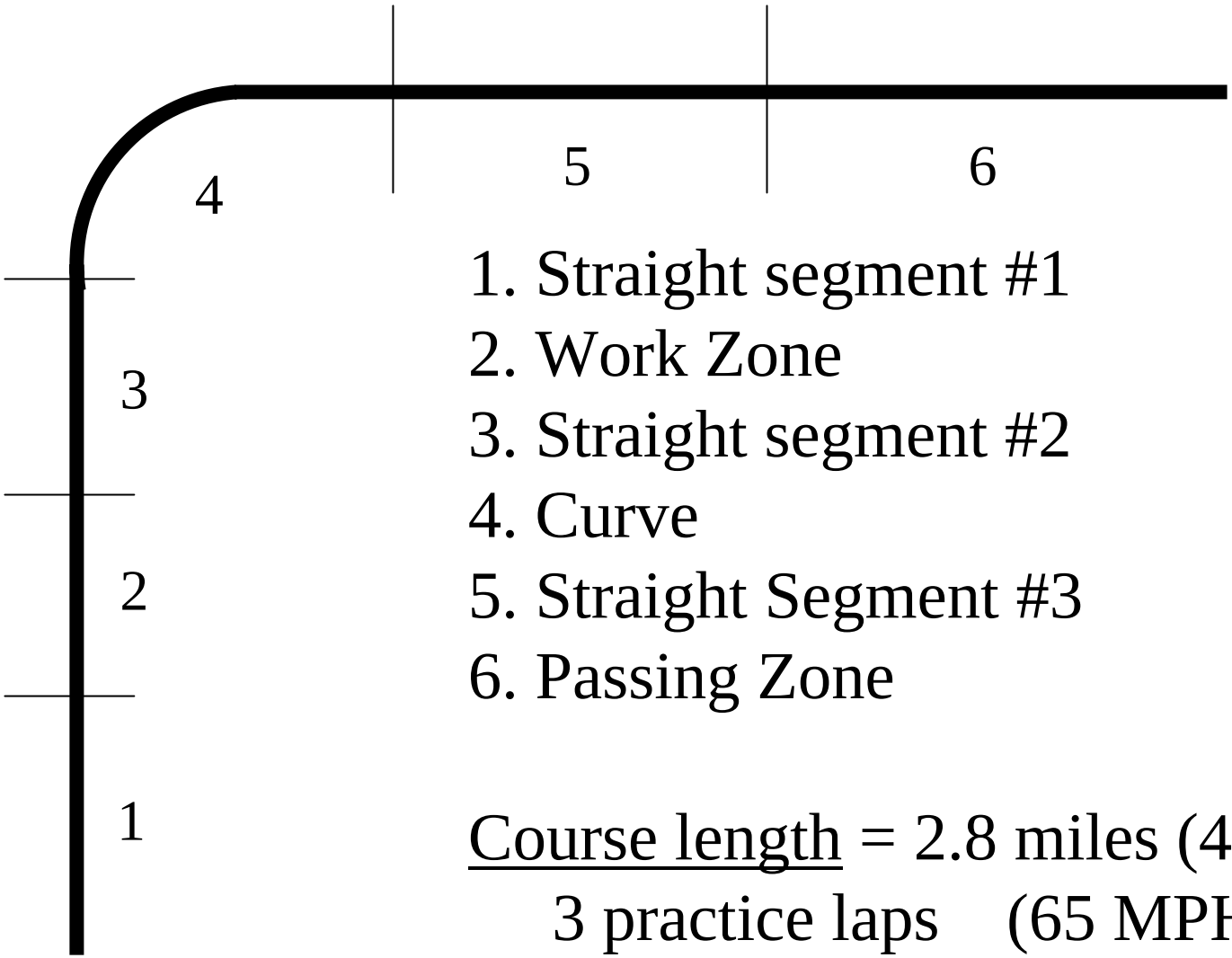
Accuracy and precision of video-based determinations of driver gaze location (Schieber, Harms, Berkhout & Spangler, 1997)

Visual Demand Proxy Measures



1) Latency of 1st Glance
2) Number of Glances
3) Mean Glance Duration
4) Total Eyes-on-Road Time (sum of interglance times)
5) Total Elapsed Time

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)

3 practice laps (65 MPH Freeway)

8 experimental laps

Results

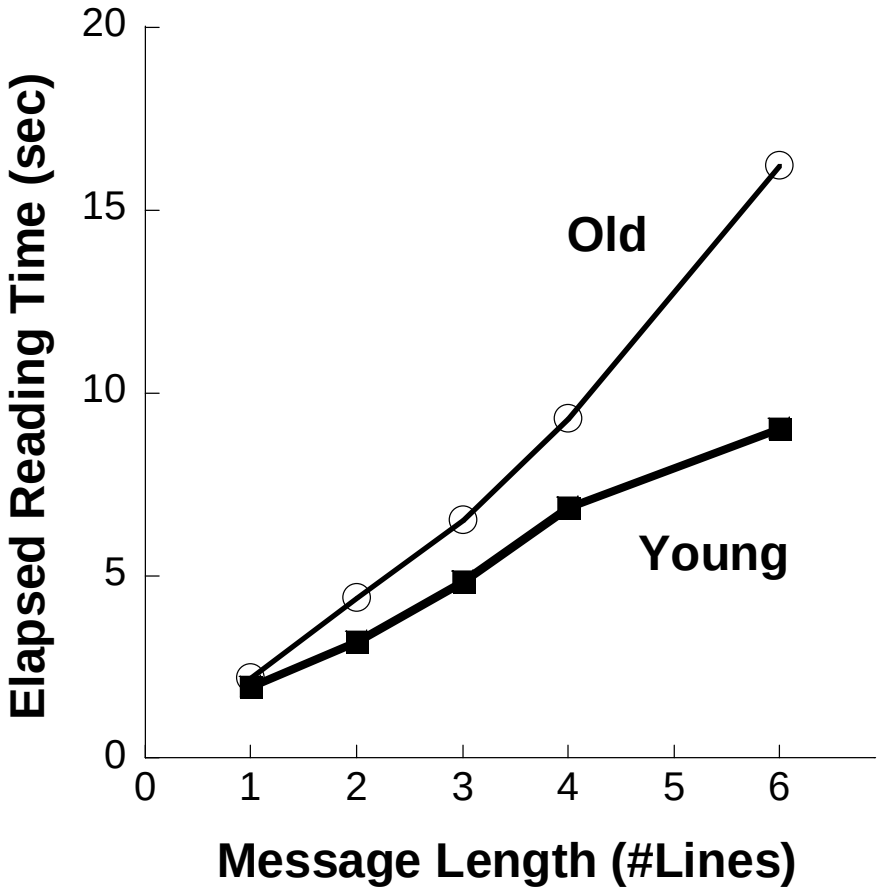
All dependent variables subjected to
(2) Age by (5) Message-Length ANOVA

1st Glance Latency

- Significant main effect of AGE
- Regardless of message length, older drivers waited longer before reallocating their gaze from the roadway to the IVIS display (upon onset of new message & warning tone)

  Old (mean = 1.12 sec)
  Young (mean = 0.54 sec)

Total Elapsed Reading Time



Highly significant interaction (0.001)

Cost of increasing message length was greater for older drivers.

Examination of other gaze measures needed to better understand the nature of this effect.

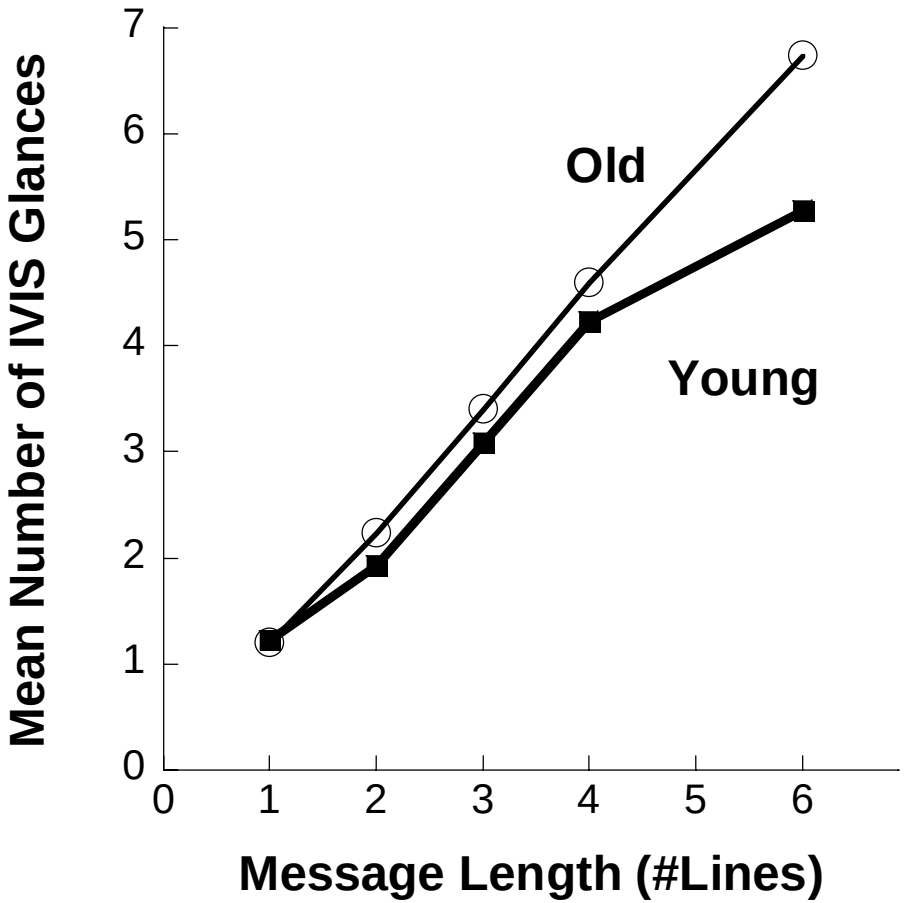
Mean Reading Glance Duration

- Main effect of Message Length (0.007)

  Gradual increase in glance duration as message length increased from 1 thru 6 lines (from 1.06 to 1.25 sec).
- No Age main effect or interaction

  Increases in per-glance duration cannot account for age-related increases in total elapsed time.

Number of Glances Required to Read Message

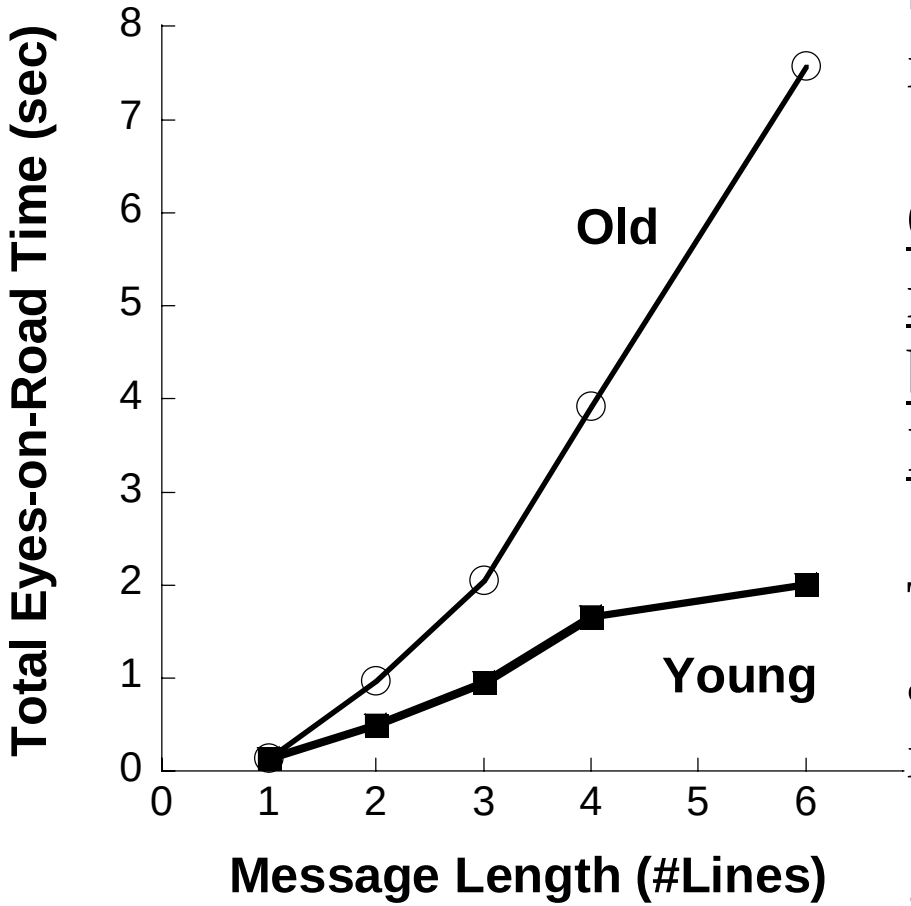


Significant Age x Message Length interaction (0.039)

Pairwise Age contrasts significant only for message length = 6 lines.

N of Glances cannot account for age-related increase in total elapsed time.

Total Eyes-on-Road Time



Significant Age by Message Length interaction (0.001)

Older drivers needed to inspect the roadway for greater periods of time between successive glances to the IVIS display.

This effect appears to completely account for the age-related increase in total elapsed time observed earlier.

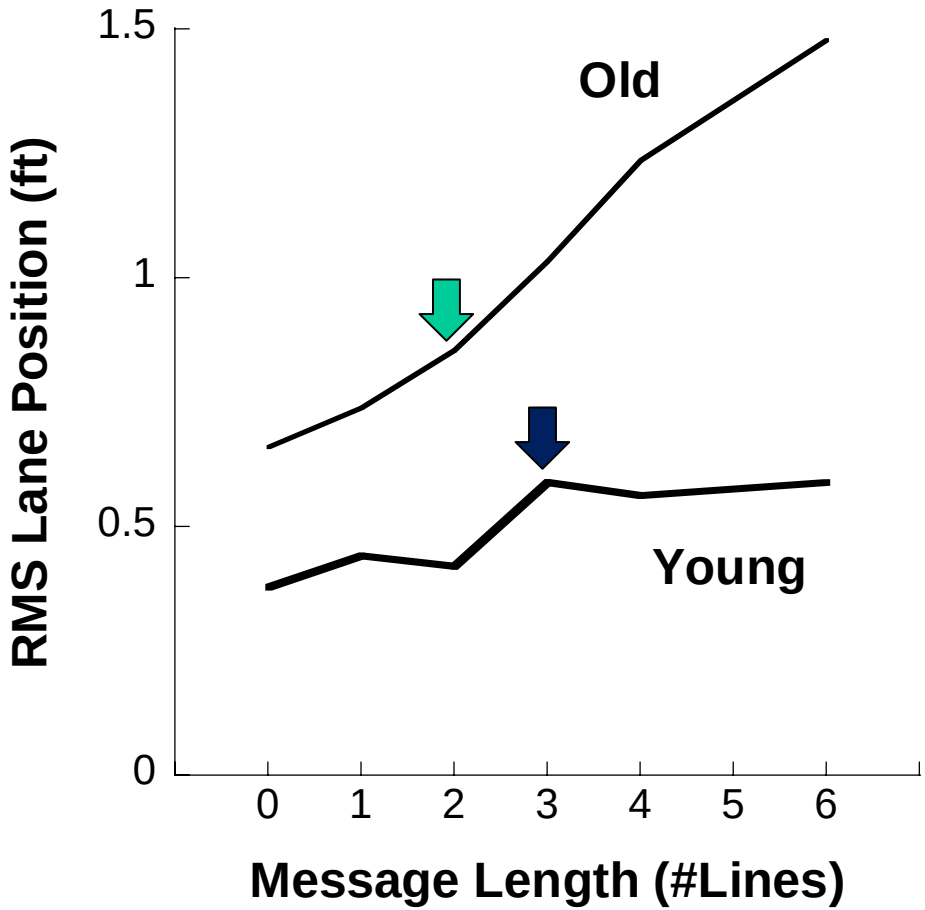
SA decay effect???
Attention switching problem?

Driving Perfomance (Average Speed; RMS Lane Position)

Significant Age by Message Length interaction for maintenance of lane position (0.001).

Older drivers demonstrated significant reductions in speed for messages longer than 3 lines (54 versus 59 MPH).

Attempts to compensate via speed reductions were not of sufficient magnitude to eliminate lane-keeping decrements.



Summary

- Large increase in the overall time needed by older drivers to read messages requiring more than a single glance.
- Age-related increase in total elapsed time is not due to the need for longer glances or more glances.
- Elevations of interglance time (eyes-on-road time) account for virtually all of the age-related slowing.

Summary (cont.)

- Why the need for greater eyes-on-road time?

  (1) Need to re-establish Situation Awareness?
  (2) Attention switching deficit?

  (e.g., Korteling, 1991; Ball, et al., 1993; Verwey, 2002)

- Age-related increase in 1st Glance Latency consistent with attention switching mechanism ("reallocation" or "disengagement" problem)
- Obviously, more research is necessary in order to better understand this real and replicable phenomenon.

Thank you for your periodic reallocation of attention.

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

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