



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

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

**CRITICALLY APPRAISED PAPER (CAP)**

***Focused Question***

**What is the evidence for the effect of automobile-related modifications on the driving ability, performance, and safety of the older adult? Modifications include changes by the industry that enhance or hinder the driving ability, performance, and safety of the older adult.**

Wolffsohn, J. S., McBrien, N. A., Edgar, K., & Stout, T. (1997). The influence of cognition and age on accommodation, detection rate and response times when using a car head-up display (HUD). *Ophthalmic and Physiologic Optics*, 18(3), 243–253.

**PROBLEM STATEMENT (JUSTIFICATION OF THE NEED FOR THE STUDY)**

State the problem the authors are investigating in this study.

Cognitive demand can affect driving behavior. It is uncertain what effect the cognitive demand of the HUD image task has. Any differences with age on HUD-assisted driving performance still needs to be assessed.

Loss of visual acuity as a result of inappropriate accommodation may lead to a reduction in cues to distance, thus distorting depth perception and possibly affecting driving performance.

**RESEARCH OBJECTIVE(S)**

List study objectives.

To determine the effect of cognitive demand and age on the use of a car HUD.

**DESIGN TYPE:**

Mixed Factors, Nonrandomized

**Level of Evidence:**

II

Limitations (appropriateness of study design):

Was the study design type appropriate for the knowledge level about this topic? *If no, explain.*

Yes

No

**SAMPLE SELECTION**

How were subjects selected to participate? Please describe.

Convenience—volunteers

**Inclusion Criteria**

- Able to attain at least 6/6 visual acuity in each eye
- Current driving license

**Exclusion Criteria**

History of binocular vision anomalies, current medication, poor general health, or ocular pathology

Sample Selection Biases: *If yes, explain.*

Volunteers/Referrals

Yes

No

Attention

Yes

No

Others (list and explain):

**SAMPLE CHARACTERISTICS**

$N = 24$  drivers (age 19–24,  $N = 8$ ) (age 35–44,  $N = 8$ ) (age 49–74,  $N = 8$ )

% Dropouts

#/(%) Male

#/(%) Female

Ethnicity

Disease/disability diagnosis

NR = Not reported.

Check appropriate group:

<20/study group	20–50/study group	51–100/study group ✓	101–149/study group	150–200/study group
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Sample Characteristics Bias: *If no, explain.*

If there is more than one study group, was there a similarity between the groups?

Yes

No

NR

Were the reasons for the dropouts reported?

Yes

No

**INTERVENTION(S)**—Included are only those interventions relevant to answering the evidence-based question.

*Add groups if necessary.*

Groups 1, 2, and 3

Brief Description	All three groups received 3 levels of cognitively demanding road tasks. A low cognitive task had stimuli presented at a rate of 6 events/min, a medium cognitive task had the speedometer cross 28 mph and was presented at a rate of 12 changes/min, and finally the high cognitive task was when the speedometer was between 28 and 32 mph and presented at a rate of 20 changes/min. The conditions that these cognitive tasks were presented in were daytime illumination and nighttime illumination.  Setting: Clinical laboratory seated 6 m from a projected screen
Setting	Clinical laboratory seated 6 m from a projected screen
Who Delivered?	Not reported
Frequency?	2 runs were carried out for each condition
Duration?	Approximately 1 hour per subject

Intervention Biases: *Explain, if needed.*

Contamination

Yes

No

Co-intervention

Yes

No

Timing

Yes

No

Site

Yes

No

Use of different therapists to provide intervention

Yes

No

NR

**MEASURES AND OUTCOMES**—Included are measures relevant to answering the focused question.

Name of measure:

Accommodative response

Outcome(s) measured (what was measured?):

Accommodation was measured by the modified Canon R-1 continuously recording infra-red optometer.

Is the measure reliable (as reported in article)?

Yes

No

NR  However there were reports of studies that may concern its reliability.

Is the measure valid (as reported in article)?

Yes

No

NR  However there were reports of studies that may concern its validity.

How frequently was the measure used for each group in the study?

The response was monitored for 80 s during each level of tasks.

Name of measure:

Response times

Outcome(s) measured (what was measured?):

Response times to changes in the outside world (i.e., brake lights) and the virtual HUD image made by 2 foot pedals. A left foot pedal response was required whenever the brake lights of the car in front were illuminated, and a right foot pedal response was required for changes in the HUD indicators as presented at 3 different levels of cognitive demand.

Is the measure reliable (as reported in article)?

Yes

No

NR

Is the measure valid (as reported in article)?

Yes

No

NR

How frequently was the measure used for each group in the study?

The response time was measured for every task and every condition.

Name of measure:

Detection rates

Outcome(s) measured (what was measured?):

Ability of the subject to detect information from the outside world and HUD task measured by response or no response to the various stimuli.

Is the measure reliable (as reported in article)?

Yes

No

NR

Is the measure valid (as reported in article)?

Yes

No

NR

How frequently was the measure used for each group in the study?

Every time a stimulus was presented during every condition

Name of measure:

Subjective opinion posttask questionnaire

Outcome(s) measured (what was measured?):

Subjective opinion of perceived difficulty of the various levels of tasks and conditions

Is the measure reliable (as reported in article)?

Yes

No

NR

Is the measure valid (as reported in article)?

Yes

No

NR

How frequently was the measure used for each group in the study?

One time postexperiment

Measurement Biases

Were the evaluators blinded to treatment status? *If no, explain.*

Yes

No

Recall or memory bias? *If yes, explain.*

Yes

No

Others (list and explain):

Limitations (appropriateness of outcomes and measures) *If no, explain.*

Did the measures adequately measure the outcome(s)?

Yes

No

**RESULTS**

List results of outcomes relevant to answering the focused question.

Include statistical significance where appropriate ( $p < 0.05$ ).

Include effect size if reported.

Cognitive demand and driving condition

*Accommodative response*

There was a significant increase for all age groups in the mean accommodative response with increased cognitive demand in the HUD task ( $p < .001$ ). There was no significant difference between accommodative response to the day and night scenes for any cognitive tasks ( $p = .43$ ).

*Response times*

There was a significant increase in response times to changes in the virtual HUD image with increased cognitive demand in both day and night scenes (all  $p < .001$ ). There was a significant increase in response times to changes in the car brake lights with increased cognitive demand in the HUD image task ( $p < .0001$ ) when viewing during the night ( $p < .01$ ) but not the day.

*Direction rates*

There was a significant increase in the percentage of virtual HUD image changes not detected with increased cognitive demand in the HUD image task with both day and night conditions (all  $p < .001$ ).

*Subjective opinion*

Subjects perceived 3 distinct levels of difficulty between the 3 virtual HUD tasks. There was no perceived difference between viewing the day and night conditions on how easy the subjects found the task ( $p = .09$ ).

Age effects

*Accommodative response*

No significant differences were found in the mean accommodative response across all cognitive levels between the 3 age groups ( $p = .98$ ). The mean dark focus of subjects significantly decreased with age ( $p < .05$ ) but the significance was only between the younger and older groups.

*Response times*

Mean response times to changes in the HUD image ( $p < .01$ ) and car brake lights ( $p < .05$ ) significantly increased with increasing age.

*Detection rates*

The mean percentage of changes in the HUD image ( $p = .001$ ) and car brake lights ( $p < .05$ ) not detected increased with increasing age.

*Subjective opinion*

There was no significant difference of perceived difficulty between all of the age groups.

Was this study adequately powered (large enough to show a difference)? *If no, explain.*

Yes

No

Were appropriate analytic methods used? *If no, explain.*

Yes

No

Were statistics appropriately reported (in written or table format)? *If no, explain.*

Yes

No

## CONCLUSIONS

State the authors' conclusions that are applicable to answering the evidence-based question.

Changes in accommodative response between viewing low and high cognitive demand HUD images were less for the oldest group, suggesting that physiological aging changes result in a reduced accommodative response in either direction. Still, some aspect other than accommodation resulted in the poorer response times and detection rates. Ocular accommodation response may prove a reliable and repeatable measure of workload in a visual task but warrants further investigation.

If the cognitive demand from the HUD was high, performance in the outside world was adversely affected. The increase in cognitive load resulted in increased response times and increased percentage of changes not detected in the HUD. This has design implications for the content and symbology used in the HUD images such as keeping symbols simple. Mean response times and the percentage of changes not detected in the HUD and car brake lights significantly increased with increasing age. Increasing HUD image cognitive demand increases over accommodation, response times, and the percentage of data not detected in the HUD and realistic scene. Driver age is an important factor to be considered when determining the amount of cognitive demand required from a HUD image in assisted driving.

Were the conclusions appropriate for the Study Design (Level of Evidence)? *If no, explain.*

Yes

No

Were the conclusions appropriate for the statistical results? *If no, explain.*

Yes

No

Were the conclusions appropriate given the study limitation and biases? *If no, explain.*

Yes

No

## IMPLICATIONS FOR OCCUPATIONAL THERAPY

This section provides guidance about clinical practice, program development, and other implications of the study findings as they relate to the focused question.

This statistically significant evidence suggests that age is an important factor for clinicians to consider when working with clients considering HUDs for their cars. If a client is older, clinicians may want to suggest HUDs that have a simpler design and lower cognitive demand. Furthermore, this article suggests that a person at any age may benefit from lower cognitive demand devices that would reduce the amount of detection errors and slow responses affect driving performance.

This work is based on the evidence-based literature review completed by Joseph M. Pellerito, Jr, MS, OTR with contributions from Stacey Schepens, OTR.

CAP Worksheet adapted from: Critical Review Form – Quantitative Studies ©Law, M., Stewart, D., Pollack, N., Letts, L., Bosch, J., & Westmorland, M., 1998, McMaster University. Used with permission.

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



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