



## 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.**

Dingus, T. A., Hulse, M. C., Mollenhauer, M. A., Fleischman, R.N., Mcgehee, D. V., & Manakkal, N. (1997). Effects of age, system experience, and navigation technique on driving with an advanced traveler information system. *Human Factors*, 39(2), 177–199.

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

State the problem the authors are investigating in this study.

Although advanced traveler information systems (ATIS) promise to serve valuable functions, they represent a new frontier that could be hazardous if not designed and implemented appropriately. Factors regarding drivers such as difference in crash rates based on age emphasize a need to investigate a variety of ages that may use an ATIS. Furthermore, research has looked into only novice system users and not experienced users. There is a need to find efficient and safe methods of presenting complex information to drivers without overloading them.

#### **RESEARCH OBJECTIVE(S)**

List study objectives.

Study 1: address the effects of age and navigation conditions  
Study 2: address the effects of experience and navigation conditions  
Study 3: examine the features drivers selected and how they used the information provided

#### **DESIGN TYPE:**

Mixed Factor, Complete Factorial Design

**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
- Participants for the first these studies were selected from visitors to Orlando recruited through AAA.

**Inclusion Criteria**

- Study 1 and 2:
- Understand normal speech in a moving vehicle
  - 20/40 vision or better
  - No apparent conditions that would interfere with their driving capabilities
  - Unfamiliar with the Orlando area
- Study 2:  
High-mileage drivers living with Orlando traffic network

**Exclusion Criteria**

- Under legal driving age
- For study 3, drivers under the age of 25 couldn't participate due to insurance constraints.

Sample Selection Biases: If yes, explain.

Volunteers/Referrals

Yes

No

Attention

Yes

No

Others (list and explain):

**SAMPLE CHARACTERISTICS**

**Study 1**

*N* = 18

% Dropouts	<input type="text" value="NR"/>		
#/(%) Male	<input type="text" value="9"/>	#/(%) Female	<input type="text" value="9"/>
Ethnicity	<input type="text" value="NR"/>		
Disease/disability diagnosis	<input type="text" value="NA"/>		

Age groups: younger: 16–18; middle aged: 35–45; older adults: 65–73

NR = Not reported.

**Study 2**

*N* = 12

% Dropouts	<input type="text" value="NR"/>		
#/(%) Male	<input type="text" value="6"/>	#/(%) Female	<input type="text" value="6"/>
Ethnicity	<input type="text" value="NR"/>		
Disease/disability diagnosis	<input type="text" value="NA"/>		

Age groups: younger: 16–18; middle aged: 35–45; older adults: 65–73

**Study 3**

*N* = 1203

% Dropouts	<input type="text" value="53 excluded"/>		
#/(%) Male	<input type="text" value="913"/>	#/(%) Female	<input type="text" value="290"/>
Ethnicity	<input type="text" value="NR"/>		
Disease/disability diagnosis	<input type="text" value="NA"/>		

Age groups: 25–34 (*N* = 220); 35–44 (*N* = 431); 45–54 (*N* = 319); 55–64 (*N* = 130); 65+ (*N* = 50)

Check appropriate group:

**Study 1 and 2**

<20/study group	20–50/study group	51–100/study group	101–149/study group	150–200/study group
✓				

**Study 3**

<20/study group	20–50/study group	51–100/study group	101–149/study group	150–200/study group
✓				

Sample Characteristics Bias: *If no, explain.*

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

Yes

No

All groups analyzed were matched for age and gender. For the second study, however, experience time varied between the subjects because the drivers used the different displays for varying amounts of time during the 6-week test period. Furthermore, the drivers varied in experience of each of the systems during the 6-week test period, using the systems unequally due to variables such as preference.

For study 3, the researchers stated that the experiment was quasi-experimental and had no equal numbers of drivers, trips, or selections of features.

Were the reasons for the dropouts reported?

Yes

No

In Study 3, for the purposes of analyzing age effects, only 1150 were usable because of the absence of some age values in the demographic screening data.

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

Study 1 and 2

6 navigation configurations were used:

- Turn-by-turn guidance with voice guidance
- Turn-by-turn guidance without voice guidance
- Route map with voice guidance
- Route map without voice guidance
- Textual paper direction list
- Conventional paper map

4 types of roadway configurations:

- Residential streets
- 2-lane arterial
- Multilane arterial
- Freeway

*Add groups if necessary.*

Groups 1–3: broken down into the three age groups as previously described.

Group 1

Brief Description	Subjects used 6 of the different configurations of navigational systems, one for each route, along with 4 different navigational conditions
Setting	Orlando Florida roads
Who Delivered?	NR
Frequency?	Each origin/destination route had an average travel time of 20 minutes during off-peak hours and participants had to complete the destination in less than 60 minutes; and all subjects had to complete 6 of these routes
Duration?	Length of driving specific route

Groups 1–5: divided by age groups as described above.

Group 2

Brief Description	Each trip that the subjects took in their rental car was considered a trial
Setting	Naturalistic field study (i.e., subjects used their rented car at their leisure, for whatever destination they chose)
Who Delivered?	Naturalistic, data was collected electronically
Frequency?	Varied based on the participants
Duration?	Length of rental period: average of 5 days

Intervention Biases: *Explain, if needed.*

Contamination

Yes

No

Co-intervention

Yes

No

Timing

Yes

No  Experimenters controlled for traffic congestion causing differences in drive time by completing testing during off-peak hours only.

Site

Yes  Experimenters used 13 different criteria to determine the origin/destination routes that contained similar driving loads (e.g., number of turns).  
For study 3, the site varied based on where the participant chose to drive or the duration of that drive.

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:

Measure of Driving Performance

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

Determined by assessing time spent scanning the roadway environment and navigation aids, lateral acceleration variance, longitudinal acceleration variance.

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?

During all origin/destination points

Name of measure:

Measure of navigation performance

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

Determined by assessing number of wrong turns, completion of the trip, trip planning time, travel time, driving safety measures.

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?

During all origin/destination points

Name of measure:

Measure of driving safety

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

Determined by safety related errors such as glance durations, lane deviations, reaction to external hazardous events, slow speeds.

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?

Throughout experiment

Name of measure:

Objective performance data collected through automatic TravTek data logging.

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

Driver interactions with the vehicle systems (button presses, cell phone calls, etc.) as well as vehicle location, speed heading, and Traffic Management Center communications, were time stamped and stored by computer.

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?

Any time the participant took a trip in his or her car. Average length of use was 5 days.

Name of measure:

Questionnaires and interviews subjective data

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

Measuring the participants' ATIS experience

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?

At the end of rental period

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.

**STUDY 1**

There were significant differences for age groups ( $p < 0.05$ ) for variance in lateral acceleration, variance in longitudinal acceleration, and number of large steering reversals. Significance was found between age and navigation condition for the duration of glances to the navigation aid. Significance of interaction between Group x Navigation condition was found ( $p < 0.0001$ ). Variance in lateral acceleration differed among age groups  $p = 0.02$ , with older drivers driving more cautiously than young drivers. Oldest drivers had lower longitudinal acceleration variance compared to the other two groups  $p = .005$ . The oldest group had significantly more large steering reversals than the other two groups ( $p = .025$ ). Interaction of age group and navigation for trip planning time was significant ( $p < 0.0001$ ), older drivers taking the longest time to plan a trip especially when using the paper map. The oldest age group differed significantly from the youngest for time required to drive to a destination = .03. There were no significant differences for number of navigation errors. The oldest drivers had the most errors in four categories: inappropriate glances longer than 2.5 s ( $p < 0.01$ ); inappropriate speed ( $p < 0.001$ ), intersection-related safety errors ( $p < 0.001$ ); and lane deviations ( $p < 0.001$ ).

### STUDY 2

There were statically significant experience differences for duration of glances (i.e., experienced users glanced for shorter time ( $p < 0.05$ ) to the navigation system and number of steering reversals corrected by travel time ( $p < 0.05$ ). Lateral and longitudinal acceleration variables were not significant as experienced increased. Number of lane deviations was lower ( $p < 0.05$ ). Time taken to plan the trip and time taken to plan and drive to the destination were statistically different ( $p < 0.05$ ). Number of stops and time required to drive to the destination had no significance. Experienced drivers had fewer navigational errors ( $p < 0.05$ ). Subjective workload was not significantly different with experience with an ATIS. Significant reduction in safety related errors were found.

### STUDY 3

The use of turn-by-turn with voice increased with increasing age, and voice and route map display use decreased with age when participants were given a choice. Older drivers used the SWAP feature on the steering wheel less often than younger drivers, but used the help buttons more often than younger drivers. There was no age effect for number of cell phone calls to the help desk. Use of the repeat voice steering wheel button was infrequent for all ages and no age effects were observed for the use of the repeat voice.

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

Yes

No

The first two studies were relatively small; however, the third study is powerful enough ( $N = 1150$ ) to show differences.

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

Yes  The experimenters used inferential statistics with ANOVAs and post hoc comparisons. Nonparametric statistics were used for the frequency data counts along with chi-square analysis.

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.

### Age Results from Studies 1 and 3

Older drivers in particular have difficulty driving and navigating concurrently. Older drivers consistently showed decreased performance in navigating, eye duration, and scanning behavior and planning and trip times. They had significantly more safety-related errors than younger drivers. Results do, however, show that older drivers can substantially benefit from use of ATIS configurations that are well designed, in comparison to the disadvantages they had while using the paper maps (indicated by lane deviation and increased trip planning time) and ATISs without voice (as indicated by long duration glances). They benefited most from the route planning and guidance functions of the ATIS. Older drivers benefited more from turn-by-turn information rather than full route information. Redundancy of information (i.e., use of auditory and visual information) benefited older drivers more. Youngest drivers had an easier time learning and using the TravTek, likely due to computer experience advantages of older users. In the naturalistic study, the majority of drivers used the ATIS when given the choice but it was unclear whether drivers selected the configuration that was most usable and resulted in the safest driving or were simply not motivated to change from the default condition.

### Experience Results from Study 2

Experienced drivers had fewer and shorter glances to the display, likely due to a combination of improved strategies to extract navigation information from the system with less effort and also because the novelty of the system had worn off. The reduction of this visual attention to the display resulted in better driving with increased experience. Furthermore, as drivers became familiar with the TravTek, they also became more proficient at using the system. Results also indicated navigation improvement using the paper map and paper direction list navigation conditions. Safety-related errors decreased as experience increased, possibly a result of decreased attention to the navigation aid (i.e., frequency of glances to the system), which speaks to general safety improving with user experience.

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 study revealed a couple of implications for clinical practice. The first is related to age effects on driving and the difficulty that older drivers have with navigating and driving simultaneously. Practitioners now have these significant results that highlight actual problems that elderly drivers are experiencing and that cause unsafe driving behavior. The ATIS is a feasible option, especially the turn-by-turn configuration, which can reduce these unsafe driving behaviors and ultimately aid in the individual's maintenance of community mobility and independence.

Another implication for clinical practice involves experience with using ATISs. This study showed that practitioners need to take into account that as the individual gains experience with using the system, the person will have safer and more efficient driving behaviors. This information could be useful during driver rehabilitation. The practitioner could first require the person to become familiarized with an ATIS in a controlled setting for a set amount of time, in order to increase his or her driving safety and efficiency before advancing to regular driving scenarios.

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

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