



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 modifications of the infrastructure of the physical environment (e.g., roadways, signage, and lighting) on the driving ability, performance, and safety of the older adult?

Chrysler, S. T., Carlson, P. J., & Hawkins, H. G. (2002). *Nighttime legibility of ground-mounted traffic signs as a function of font, color, and retroreflective sheeting type* (FHWA report #FHWA/TX-03/1796-2). Springfield, VA: National Technical Information Service.

PROBLEM STATEMENT (JUSTIFICATION OF THE NEED FOR THE STUDY)

State the problem the authors are investigating in this study.

This study was conducted because previous research was either incomplete in design, or was not conducted using the latest in microprismatic sheetings. According to the authors, most of the research conducted prior to this study was done using a paradigm in which the participant was a passive observer in the vehicle. However, the requirements of the driving task may impinge on attentiveness to the roadway and the legibility distance of the target sign. Participants in this study were asked to read the roadside signs as they piloted the vehicle themselves. In comparison to the bulk of previous research, this experimental setting more closely represented the actual task of reading signs while driving at night.

RESEARCH OBJECTIVE(S)

List study objectives.

The purpose of this study was to determine the effects of sign color on the nighttime legibility distance of 3 different fonts commonly used on highway signage. The target population was older drivers (aged 55–75).

DESIGN TYPE:

Randomized controlled trial

Level of Evidence:

Level I

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—as volunteers

Inclusion Criteria

Aged 55–75, licensed drivers. Visual acuity and contrast sensitivity tests were administered as well, and participants all scored within acceptable ranges.

Exclusion Criteria

Aged greater than 75 or less than 55.

Sample Selection Biases: *If yes, explain.*

Volunteers/Referrals

Yes

No

Attention

Yes

No

Others (list and explain):

Participants were selected either through personal relationships with the researchers, or from lists of participants from previous studies.

SAMPLE CHARACTERISTICS

N = 24

| | | | |
|------------------------------|----------------------------------|--------------|---------------------------------|
| % Dropouts | <input type="text" value="N/A"/> | | |
| #/(%) Male | <input type="text" value="12"/> | #/(%) Female | <input type="text" value="12"/> |
| Ethnicity | <input type="text" value="N/A"/> | | |
| Disease/disability diagnosis | <input type="text" value="N/A"/> | | |

Check appropriate group:

| | | | | |
|---|-------------------|--------------------|---------------------|---------------------|
| <20/study group <input checked="" type="checkbox"/> | 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 There were 2 age ranges, 55–64 and 65–74. Each age range had an equal gender split.

No

Were the reasons for the dropouts reported?

Yes

No

N/A

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

| |
|---|
| <p>Participants were asked to pilot a 1998 Chevy Lumina that had been fitted with a distance-measuring instrument. The headlamps on the Lumina were HB4 halogens. Only the low-beam headlamps were used in this study. The participant was in full control of the vehicle at all times, and was asked not to exceed 30 mph during the duration of the experimental drive.</p> |
|---|

The study was conducted on the runways of an abandoned Air Force base that is now used by Texas Transportation Institute for on-road research studies. Data were collected under cover of darkness under clear and dry weather conditions. A total of 48 signs were placed along the road at 500-ft intervals. However, curvature in the roadway and turns in the course necessitated greater spacing intervals at certain locations. To control for potential confounding due to these environmental constraints, the signs were swapped between locations after every 8 subjects. It was impractical to change all 48 signs after each subject. This yielded 3 different sign-presentation orders.

Four sign colors were used: green, orange, white, and yellow. A single, unique 4-letter word was printed on each sign. Half of all the signs were printed with the Highway Series D font. The remaining green signs were printed with the Clearview Road Condensed font, while the remaining yellow, orange, and white signs were printed with the D-Modified font. This is because green guide signs appear on the roadway with white typeface, which is highly reflective; orange, white, and yellow signs feature black text, which is not reflected. The Clearview font is indicated for use only where the font will be reflected more brightly than the background. The words on all signs were printed with 6-inch uppercase letters.

Three different types of retroreflective sheeting were used: Type III, Type VIII, and Type IX. For each sheeting type, 16 signs were produced—2 for each combination of sign color and font, each with its own unique word.

Signs were positioned alongside the right side of the roadway. The signs were positioned 14 feet from the fog line to the center of the sign. Signs were placed 8 ft above the road surface to the center of the sign.

Add groups if necessary

Group 1

| | |
|-------------------|--|
| Brief Description | |
| Setting | |
| Who Delivered? | |
| Frequency? | |
| Duration? | |

Intervention Biases: *Explain, if needed.*

Contamination

Yes

No

Co-intervention

Yes

No

N/A

Timing

Yes

No

Site

Yes

No

Use of different therapists to provide intervention

Yes

No

N/A

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

Name of measure:

Legibility Distance

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

Distance from sign at which participants correctly read the word on the sign aloud.

Is the measure reliable (as reported in article)?

Yes

No

Is the measure valid (as reported in article)?

Yes

No

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

Each participant saw each of the 48 signs once.

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.

An ANOVA was conducted using age as a between-subjects factor, and sheeting, font, and color as a within-subjects factor. There was no main effect for age group, but sign color and sheeting revealed significant main effects at $p < 0.0001$. For color, orange signs performed the worst with a mean legibility distance of 164 ft. This was significantly worse than all other colors. Yellow and white signs were significantly better, with mean distances of 190 and 188 ft, respectively. Green signs significantly outperformed orange signs with a mean of 179 ft. This was not significantly different from the white signs, but was significantly worse than the yellow signs.

There was also an interaction for the color and age factors. This was due to much poorer performance of the older group (aged 65–74) when reading the orange signs.

The analysis of sheeting type indicated that Type VIII (mean = 184 ft) and Type XI (mean = 183 ft) outperformed Type III sheeting (mean = 174 ft). There was also an interaction effect for sheeting type and color, but font-type and color were not fully crossed. Therefore separate ANOVAs were required for each sign color to explore this difference without font confounding the effect of color.

The green signs were the only signs to use the Clearview Condensed font. Therefore, the analysis of this font occurred separately from that for the other signs. The Series D font yielded a higher mean legibility distance (187 ft) than the Clearview Condensed font (171 ft). This difference was significant at $p = 0.006$, and ran counter to previous literature, which had demonstrated modest gains in legibility distance for the Clearview family of fonts. On the green signs, the type of sheeting used was significant at $p = 0.013$. Type IX sheeting had a mean legibility distance of 188 ft, while type VIII yielded a mean of 175 ft, and type III had a mean of 173 ft. Post-hoc tests showed that the only significant difference was between the type IX sheeting and the type III sheeting.

The 3 remaining color signs were considered in a separate ANOVA, which was able to assess the differences between the Series D and D-Modified fonts. There was a significant interaction ($p = 0.002$) for font type and sign color. As the pattern of results varied with color, the effects of font and sheeting type on each of the 3 included sign colors will be addressed individually.

The orange signs showed no significant main effect for font type, however there was a highly significant effect ($p = 0.0001$) of sheeting type, with type IX (mean = 169 ft) and type VIII (mean = 175 ft) sheeting outperforming type III sheeting (mean = 148 ft).

In the white signs, a statistically significant main effect for font type was claimed, however no p -value was provided. In this case, the D-modified font yielded a mean legibility distance of 195 ft, while the Series D font only yielded 181 ft. There was no effect for sheeting type, or any significant interactions.

For yellow signs, there was no significant effect for the font type. However, the main effect of sheeting type was significant at $p = 0.0026$. Type VIII sheeting outperformed both type IX and type III sheeting, with mean legibility distances of 200 ft, 188 ft, and 183 ft, respectively. There was no significant difference between the type IX and type III sheeting, and no significant interactions.

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.

Regarding sheeting types, the authors suggest that although there were statistically significant differences between sheeting types depending on what color sign was used, the practical difference between the signs ranged a mere 17 ft. At 60 mph, this difference represents 0.2 seconds of additional reading time. The authors concluded that this modest gain might not justify the additional cost of using more expensive sheeting.

The authors were surprised that the Clearview font did not perform better than a traditional font, as has been shown by previous studies. This may be due to the fact that the words used in this study were written using all capital letters, while other studies have used upper and lowercase letters.

One factor that may have played a role in shaping the results is word choice. Because each word appeared only once, it is possible that certain words were more difficult to read than others, and this may have confounded the results. While a small-scale screening of the words was used in an attempt to weed out those too easy or difficult to indicate, it is possible that this assessment was not sufficiently rigorous.

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.

The only definitive recommendation for change of the authors is that orange signs used in construction zones should utilize type VIII or type IX sheeting, which outperformed the type III sheeting for the orange sign color. Even though the safety benefits shown for the different sheetings were significant, there is some question regarding how much of a safety benefit can be expected for relatively small improvements in legibility distance.

This work is based on the evidence-based literature review completed by Paula C. Bohr, Ph.D., OTR/L, FAOTA and Kathleen A. Harder, PhD.

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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