The Effects of Changeable Message Signs (CMSs) on Older Driver Behavior

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Summary of CMS Research


• Harder and Bloomfield (2010). Comparison of Dual Phase and Static Changeable Message Signs Used to Convey Airline Information on Interstate Freeways, Mn/DOT 2010-02.
Research Objectives

• Investigate whether messages presented on CMSs cause slow downs and, if so, do the slowdowns vary by driver age group?
• Investigate driver behavior in response to Changeable Message Signs (CMSs) displaying various messages.
Experimental Design for the 3 CMS Studies: Participants

- Participants—120 licensed drivers.
- 40 participants in each of three age groups—18-24, 32-47, and 55-65.
- In each age group—20 females & 20 males.
- Participants recruited from Twin Cities metropolitan area.
  - Studies 1 and 2: Reported regularly commuting on interstate highways
  - Study 3: Commuting on interstates was not a requirement
- Participants were reimbursed for their participation.
STISIM Driving Simulator
Traffic-Related CMS: Study 1
The change in speed from segment to segment for each age group as the participants approach the Thompson Exit Message.
Individual Examination of Slow Downs on Approach to Crash 1

• Sixteen (13.3%) of the participants in the experiment, slowed down by at least 2 mph
  – 8.2% (10/120) slowed down by at least -4 to -5 mph.
  – 3.3% (4/120) of the participants slowed down by at least -10 to -11 mph
• BUT—no statistically significant effect for Age
  – However, 9 of 16 who slowed down were older drivers.
Driver Response to Message in Study 1

• Number of participants who took Thompson Exit in Phase I: 67/120 (55.8%)

• Age—significant effect ($p < 0.05$)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Younger Group (18 to 24 years old)</th>
<th>Middle Group (32 to 47 years old)</th>
<th>Older Group (55 to 65 years old)</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Took Exit</td>
<td>14</td>
<td>24</td>
<td>29</td>
<td>67</td>
</tr>
<tr>
<td>Did Not Take Exit</td>
<td>26</td>
<td>16</td>
<td>11</td>
<td>53</td>
</tr>
<tr>
<td>Totals</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>120</td>
</tr>
</tbody>
</table>
Traffic-Related in Study 2
Driver Response to Message in Study 2

- Number of participants in Study 2 who took Thompson Exit was: 112/120 (93.3%)
- Age had no effect on whether or not participants took the Thompson Exit, as directed by the CMS.
  - Illustrates the effect that clearer, less ambiguous wording has on driver behavior.
Mean Speed as a Function of Age and Highway Segment on Approach to Thompson Exit
Amber Alert: Study 1
Results for Amber Alert: Study 1

• The number of participants who recalled some vehicle information and at least five of the six alphanumerics on the license plate was—

  10/120 (8.3%)
  (only 2/120 had perfect recall).

BUT—no age-related effect on recall of Amber Alert Message

• 32 participants did not know what Amber Alert referred to.
The change in speed from segment to segment for each age group as the participants approach the AMBER Alert
Individual Examination of Driver Slow Downs on Approach to Amber Alert 1

- Twenty-six of the 120 participants—i.e., 21.7%—slowed down by at least 2 mph in the 860-foot road segment before the AMBER Alert;
  - 16.7% (12/120) slowed down by at least -4 to -5 mph; and
  - 1.7% (2/120) slowed down by at least -10 to -11 mph.

- Age Effect on slow-downs that occurred as the participants approached the AMBER Alert:
  - 42.5% of the Older Group slowed down—they were eight times more likely to slow down than the Younger Group.
Amber Alert in Study 2
Results for Amber Alert (Abducted Child): Study 2

• The number of participants who recalled enough information to allow them to tune to the correct radio station was: 86/120 (71.7%).
• No effect for participant age.
• All knew what abducted referred to.
Did Amber Alert 2 Cause Driver Slow Downs?
Speed Data on Approach to Amber Alert 2

- ANOVA indicates a statistically significant effect of Age on average speeds:
  - Older Drivers—55.6 mph
  - Middle Age Drivers—59.8 mph
  - Younger drivers—60.6 mph

[For Amber Alert 1, average speeds were approximately
55 mph for the Older Drivers, 58 mph for the Middle Age Drivers, and 65 mph for the Younger Drivers.]
Switching gears to CMS Study 3 regarding airport signage…
Research Question CMS Study 3:

• Problem: Not possible to display information simultaneously about all nine airlines at Lindbergh Terminal on one CMS sign and have them visible at a reasonable distance.

• What’s the most effective way to present the airline information? Dual-phase or static CMSs?
Research Approach:

- Two alternative methods for displaying airline information were investigated:
  1. airline information displayed on two separate static CMSs—one CMS located a short distance after the other on the highway approach
  2. information displayed on a single CMS, sequentially, in two phases.
Research Approach

• We used driving simulation to test both alternatives to:
  – compare whether the drivers took the appropriate highway exit.
  – evaluate whether or not the CMSs caused the drivers to reduce their driving speed.
Purpose of All Previous CMS Investigations (not just Harder and Bloomfield):

- Capture driver attention
- Inform driver of a problem
- Indicate requested action
- All information displayed on CMSs geared toward to all drivers
This Study Differs from Previous CMS Studies in that:

• Drivers were asked to seek information displayed on the CMSs to discover the terminal housing their airline.

• A search and recognition task rather than a memory recall task.
Method: Participants

- Participants—120 licensed drivers.
- 40 participants in each of three age groups—18-24, 32-47, and 55-65.
- In each age group—20 females & 20 males.
- Participants were recruited from Twin Cities metropolitan area.
- Each participant was paid $50 for his/her participation.
Method: Simulated Roadway

• Study participants were unfamiliar with the airport approach simulated in this experiment.
  – People who are familiar with the airport don’t need signage to tell them where to go.
• Number of overpasses and highway signs on the simulated approach were the same as the last eleven miles of westbound approach to MSP on I-494
• But content on highways signs was changed
• And roadside features were different than the actual westbound I-494 approach
• 11 miles long; six lane divided highway
## Locations of CMS Signs in Both Dual-Phase and Static Conditions

<table>
<thead>
<tr>
<th>Distance (from Terminal 2 CMS)</th>
<th>Location of CMS in Dual-Phase Condition</th>
<th>Location of CMS in Static Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,300 ft</td>
<td>Terminal 1 Dual-Phase CMS</td>
<td>Terminal 1 First Static CMS</td>
</tr>
<tr>
<td>800 ft</td>
<td>-----</td>
<td>T1 Second Static CMS</td>
</tr>
<tr>
<td>0 ft</td>
<td>Terminal 2 CMS</td>
<td>Terminal 2 CMS</td>
</tr>
</tbody>
</table>
Sign Informing Participants they are Approaching Airport
First CMS in Static Condition: Terminal 1 Airline Information
Second CMS in Static Condition:
Terminal 1 Airline Information
Third CMS in Static Condition:
Terminal 2 Airline Information
Dual-Phase CMS Condition

- Showed all nine of the names of the airlines serviced at Terminal 1—in two distinct phases.
- The duration of each phase was two seconds—the minimum phase length required by Mn/DOT.
- CMS cycled through the two phases continuously.
- Participants saw each phase at least twice—which is an FHWA requirement (MUTCD, 2007)—as they drove toward the dual-phase CMS.
- Information showing Terminal 2 airlines posted on sign 1,300 feet down the road from the dual-phase CMS.
Method: Experimental Procedure

• Participants were randomly assigned to either the dual-phase or static condition.
• Each participant had a practice drive.
• The participant was:
  – Informed that he or she would be driving towards an airport.
  – Told which airline he or she was looking for—and was given a piece of paper with the name of that airline.
  – Told that the speed limit on the road was 60 mph.
  – Asked to “Please drive as you normally would.”
• Participant was NOT given any information about highway signage, including CMS displays.
Results

• Two types of driving performance data were collected:
  – Exit response data
  – Speed data
Results—Exit Data

• Each participant drove the route towards the airport twice—giving a total of 240 drives.

• Participants took the CORRECT exit for the airline to which they were assigned on 215 of 240 drives (i.e., on 89.6% of the drives).

• They FAILED to take the correct exit on 25 of 240 drives (i.e., on 10.4% of the drives).
Results: Exit Data—Effect of Age

Number of failures to take the correct exit in each age group.
Results: Speed Data—Effect of Age

Average speed as a function of the age of the participants
Study objective: to determine whether messages displayed on dual-phase CMSs are as effective in influencing driving behavior as messages displayed on static CMSs.

We found age differences in exit behavior and driver speed overall.

But was there a difference between the two display formats with regard to exit behavior and driver slowdowns?

– Answer: No differences!
  • No age differences
  • No gender difference
How Can We Use these Findings?

• Findings clearly show that signs that are more “cognitively digestible” (less ambiguous) lead to increased driver comprehension and compliance—across all age groups

• More research is needed regarding why more older drivers failed to take the correct exit in the airport signage study.
Thanks!

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