Research Synopsis

Title:	Effect of Luminance on Information Acquisition Time and Accuracy from Traffic Signs
Reference:	Operator Performance Laboratory, Research Project Final Report, Report No: OPL-08-021
Report Date:	August, 2008
Authors:	Tom Schnell, Lora Yekhshatyan, Ron Daiker, Jeff Konz
Conducted by:	Operator Performance Laboratory, University of Iowa
Keywords:	Luminance, Traffic Sign, Sign Legibility, Legibility Performance, Information Acquisition, Information Accuracy

Key Findings:

1. Increasing sign luminance (and/or size) provides faster information transfer from the sign to the driver
2. If viewing time is limited, higher sign luminance and/or larger sign size provides more accurate sign reading.
3. Decreasing the sign size increased the information acquisition time, but had a smaller effect on brighter signs.
4. Brighter signs decrease sign reading times, and therefore expected to reduce eyes-off-the road time. Eyes-off-the-road time is the primary characteristic of interest in automotive safety, as driving safety is compromised if one is not looking at the road[1]

Bottom Line

Drivers do not necessarily read signs at threshold legibility distances, which had been the primary focus of numerous earlier studies. Instead, this study investigates the speed and accuracy of information transfer from signs to the driver as a function of luminance and size, on the premise that, if signs transfer information faster to the driver, the eyes-off-the-road duration while reading traffic signs can be reduced, which is a primary focus in motorist safety in many studies. The findings suggest that increasing sign luminance, (within the investigated range of 3.2 cd/m^2 up to 80 cd/m^2, a reasonable range for passive retroreflective signs—white DG^3 on a right shoulder mounted sign is most likely to come closest to 80 cd/m^2 for a typical size vehicle with typical headlights) decreases information acquisition time. Likewise, reading accuracy increases with increasing brightness. Sign size also has a similar impact similar to luminance. In addition, changing contrast between legend and background from 6:1 to 10:1 had no appreciable impact on legibility performance.

[1] Dewar et al. *Human Factors in Traffic Safety*.

Study Summary

Luminance of the white letters ranged from 3.2 cd/m^2 to 80 cd/m^2 on positive-contrast (white on green) textual traffic sign stimuli with contrast ratios of 6:1 and 10:1 (background luminance was either 1/6th or 1/10th of the legend), positioned at 33 foot/inch and 40 foot/inch legibility indices viewed under conditions simulating a nighttime driving environment.

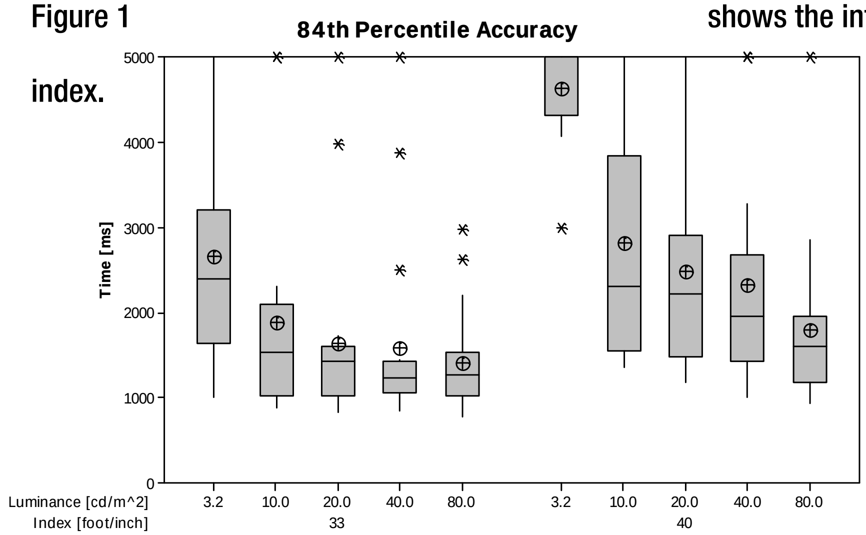
Larger and brighter signs are efficient, and require less time in providing very high reading accuracy. A 50-percent reduction in luminance required an additional 20-percent reading time on average (to achieve the same response accuracy level). The improvement was also statistically significant at each step from 3.2 cd/m^2 to 80 cd/m^2, with the following percentage differences between adjacent luminance levels on average:

80 cd/m^2 to 40 cd/m^2: 21% additional reading time
40 cd/m^2 to 20 cd/m^2: 7.1% additional reading time
20 cd/m^2 to 10 cd/m^2: 15% additional reading time
10 cd/m^2 to 3.2 cd/m^2: 50% additional reading time

Increasing the contrast from 6:1 to 10:1 did not have a significant effect on information acquisition time at neither 20 cd/m^2 nor 80 cd/m^2 luminance level.

Larger and/or brighter signs are expected to not only transfer the information quickly and efficiently, but also provide a more conspicuous target to the nighttime driver especially when scene complexity increases. Such signs are expected to occupy driver attentional resources for shorter durations and have the potential to reduce driver workload and improve safety.

Figure 1 shows the information acquisition times for the five luminance levels at each legibility index.



Note: The circles with crosshairs represent the averages. The top of the boxes represent 75th percentile, the line inside the boxes represent the median, and the bottom of the boxes represent 25th percentile. The ends of the whiskers show the range of data, and the stars show the outliers (unusual observations).

Figure 1. **The summary of the statistical data for the 84th percentile**

3M

Traffic Safety and Security Division
3M Center, Building 0235-03-A-09
Saint Paul, MN 55144-1000
U.S.A.
1-800-553-1380
www.3M.com/roadwaysafety