C60 A Luminance-Based Analysis of Olson and Sivak's 1984 Research on Visibility Response Distance to Dark-Clad Pedestrians Under Headlamp-Only Illumination

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The objective of this paper is to present a scientifically-valid method for interpolating and extrapolating Olson and Sivak's [1] experimentally derived visibility response distance distributions to dark-clad pedestrians under US low beam headlamps.

This presentation will impact the forensic community and/or humanity by demonstrating that the visibility identification luminance distribution of dark-clad pedestrians, derived from Olson and Sivak's response distance distributions, for both the left and right side of the road, fit a single normal distribution when plotted together. Therefore, it can be used to determine identification distances to pedestrians for many common nighttime vehicle/pedestrian collisions.

One of the most relied-upon studies of pedestrian visibility is a 1983 report by Olson and Sivak [1], also described in reference 2. In part of this study on low-beam headlamps, twenty-three young passenger and/or driver observers were asked to identify and respond to a target on either the right or left side of the road under headlamp illumination. One of the four potential targets was a dark-clad pedestrian wearing blue denim clothing measured at 6% reflectance. Data collected in this study were plotted as response distances on normal probability paper and resulted in mean response distances of 145 and 75 feet for pedestrians on the right and left side of the road, respectively. Figure 1 was derived by digitizing figures 3.16 and 3.17 in reference 1.

Figure 1

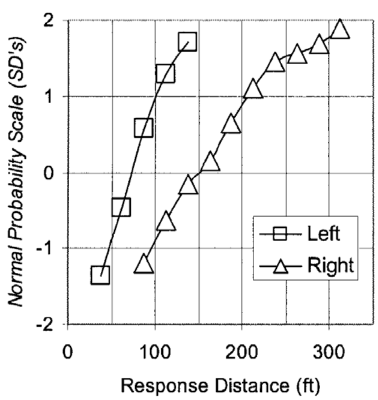
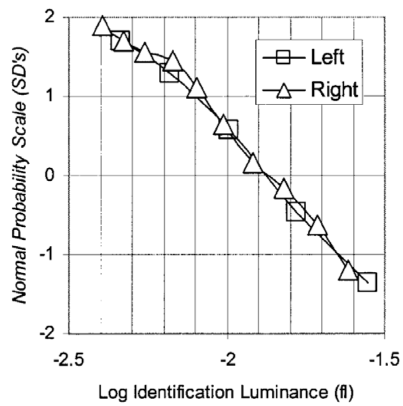


Figure 2



For relevant vehicle/pedestrian collision reconstruction, where the struck pedestrian may be standing or moving somewhere other than 9.5 feet on the left or 9.5 feet on the right of the path of the approaching vehicle, and may be wearing something other than 6% reflective clothing, it is necessary to extrapolate and/or interpolate the data contained in Figure 1. With this in mind, each point in Figure 2 was created from a point in Figure 1 as follows; 1) each response distance was converted into an identification distance; 2) identification luminance at headlamp height was calculated for each identification distance; and 3) identification luminance was plotted logarithmically to the same normal probability scale as Figure 1. The data points for the identification luminance to pedestrians standing to the left and right side of the road merge into a straight line when plotted logarithmically in figure 2, indicating a single normally distributed population of observers with a mean identification luminance of 0.014 fl at headlamp height, and a mean plus and minus one standard deviation of 0.023 fl and 0.008 fl, respectively.

Log identification luminance distributions similar to figure 2 were also determined at each distance at foot/ground level and at 4 feet up on the pedestrian. Though the curves for left and right standing pedestrians also coincide at ground level with a mean identification luminance of 0.039 fl, the better coincidence was found to be at headlamp height. The curves did not coincide at the 4 foot level. Two advantages of using luminance at headlamp height for visibility distance calculations are 1) headlamp height allows the use of the inverse square law for pedestrians located in the center of the road, and 2) illumination at headlamp height is not affected by contrast with the illuminated road surface in the same manner as illumination at ground level.

The results of this analysis allow the reconstructionist to determine visibility distance from luminance measurements or calculations for many common collisions involving vehicles operating with low beam headlamps and dark-clad pedestrians. A luminance-based analysis permits interpolation and extrapolation to be made for different pedestrian positions in the roadway and different clothing reflectances. Additionally, with a

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luminance-based analysis driver/observer statistics and expectancy considerations can be more easily quantified.

References:

Olson, P.L. and Sivak, M. (1983) Improved Low–Beam photometrics, University of Michigan Transportation Research Institute, Ann Arbor, Michigan, Report No. UMTRI-83-9.

Forensic aspects of Driver Perception and Response, Second Edition, Paul L. Olson and Eugene Farber, Lawyers & Judges Publishing Company, Inc. 2003.

Accident Reconstruction, Visibility, Illumination