C59 Assessment of Roper and Howard's 2:1 Expectancy Rule in Nighttime Motor Vehicle Accident Reconstruction

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The objective of this study is to evaluate the rationale commonly applied by accident reconstructionists to correct for the distance at which a non-expectant driver will see an obstacle in the path of his vehicle under nighttime headlight illumination based on the 1938 findings of Roper & Howard, who reported that a typical driver who expects to encounter an obstacle will first see it at twice the distance as one who is totally unaware of the obstacle's presence [1]. Attendees will learn to differentiate between motor vehicle accident scenarios to which the 2:1 expectancy rule is applicable and those to which it is not.

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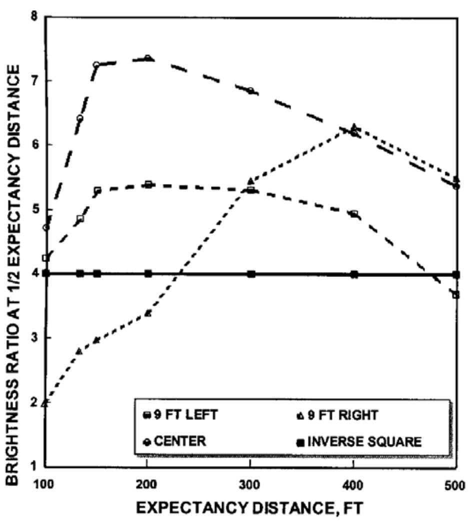
The forty six test drivers who participated in a study conducted by Roper & Howard were unaware that they were involved in a visibility experiment and would be encountering a mannequin standing in the road directly ahead of them as they test drove a vehicle down a rural roadway at night. Their reactions to this unexpected confrontation with a human-like obstacle were recorded by a strip chart recorder monitoring the drivers' foot pressures on the accelerator peddle. These measurements were then used as a basis for determining the driver's distance to the mannequin at the instant of detection. The test was then repeated with the same 46 drivers, who were now in an expectant state similar to that of test drivers in most structured visibility experiments. The analysis of these data revealed that the ratio of mannequin detection distances for 46 drivers in the non-expectant vs. expectant states was 0.50±18% (18 is ± one standard deviation expressed as a percent of 0.50). The reciprocal of 0.50 is the basis of Roper & Howard's 2:1 expectancy rule.



The headlights used by Roper & Howard were not intended to produce a distribution representative of any existing headlamp beam pattern, but were uniquely designed for the purposes of this study to produce uniform illumination throughout the area where the mannequin was standing [1]. Under this condition, mannequin brightness would have varied inversely with its distance squared, which would have resulted in a brightness ratio for non-expectant vs. expectant drivers of 4:1. Since object size, brightness and distance are all factors in object visibility, the application of Roper & Howard's 2:1 expectancy rule is strictly valid only under the conditions that the brightnesses of uniformly-illuminated humans or humanlike objects in the vehicle's path increase by a ratio of 4:1 when distances are halved. These same limitations apply to the application of the "Hyzer Shortcut Method", described by Olson & Sivak as a procedure for making first-approximation estimates of a driver's visibility limitations from an expert's field observations [2]. Following are some objects and lighting conditions that are either incompatible with Roper & Howard's 2:1 expectancy rule or need to be subjected to more critical analysis before applying it to them.

1) Retro-reflecting small signs, license plates and warning devices. Reflected brightnesses of retro-reflecting devices under uniform headlight illumination are inversely proportional to the 4th power of their distances. By reducing distances to one half, brightnesses increase by a factor of 16:1.

2) Wires, cables, ropes or chains stretched across the roadway. Reflected brightnesses of uni-dimensional objects under uniform headlight illumination are inversely proportional to the 3rd power of their distances. By reducing distances to one half, brightnesses increase by a factor of 9:1.

3) Objects illuminated by low-beam headlights: Low-beam headlights do not uniformly illuminate large objects such as pedestrians.

4) Objects located above or below headlight level or to the left or right side of the roadway: Headlight illumination is angle dependent so that the brightnesses of objects located above or below headlight level or off to

the left or right side of the roadway rarely meet the required 4:1 brightness ratio when their distances are halved, as illustrated in the above graph for the specific case of low-beam-headlight illumination of objects located to the left, center and right side of the road at ground level. Brightness ratios are shown to range from a low of 2:1 to a high of over 7:1 when distances to the objects are reduced by half, depending upon the location of the objects within the pattern of the headlight beams.

References.

1. Roper VJ, Howard EA. Seeing with motorcar headlamps. Trans Illum Eng Soc, 1938:33/417-438.
2. Olson PL, Farber E. Forensic aspects of driver perception and response. Lawyers & Judges Publ Co, 2003:pp 153-154 & 295.

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