

VISION ENHANCEMENT IN AUTOMOBILES: THE EFFECT OF DISPLAY TYPE ON PERCEPTION-RESPONSE TIME

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Vision Enhancement System (VES) technology may have potential safety benefits in the automotive domain. Vision enhancement technology may be used to highlight important features of the driving environment (e.g., pedestrians, other vehicles), thus improving a driver's ability to detect such objects and respond appropriately. However, because VES present information superimposed on the windshield in a head-up display (HUD) there are important attentional considerations. Drivers must be able to adequately divide their attention between the display imagery and the external environment without risking cognitive capture by elements of the display. The overall safety benefit afforded by a VES will depend upon the driver's ability to extract important information from highlighted objects as well as non-highlighted objects. The aim of the current study was to examine how different VES imagery may impact driver responses to surprise pedestrian crossings.

Two VES displays were designed that detected and highlighted other vehicles in the nearby environment. Conformal VES present display imagery that superimposes the real world objects so that they form a single perceptual object (Wickens and Long, 1995). Non-conformal displays present information that does not overlie the object that it augments. The conformal VES used in this study highlighted the front and rear bumpers of other vehicles with a bright green line which expanded as the vehicle approached. The non-conformal VES highlighted vehicles through the presentation of a solid green circle that appeared subtended on the roadway ahead of the driver. As the other vehicle approached, the circle expanded. Thus, the conformal VES offered drivers information about the presence and location of other vehicles in the environment whereas the non-conformal only alerted drivers of the presence of vehicles and not their location.

Thirty-two younger drivers (16 male and 16 female, $M = 23$ yrs) participated in the study. The video-based driving simulator consisted of a vehicle mock-up, projector, projection screen, computer, and digitized and modified road videos. The vehicle mock-up allowed drivers to control the playback speed of the video through brake and accelerator inputs. Frame by frame development of the road videos was performed in Adobe Photoshop and Premiere. An Asymetrix Toolbook program was developed to coordinate the inputs and outputs to and from the driving simulator (Horrey, 1999).

Participants were instructed to drive as they ordinarily would. During the last video sequence of the practice block, a pedestrian appeared on the road. Perception-response time was measured for brake responses. During an experimental block, four pedestrian surprise events were presented. Three of these

pedestrians were the same as the practice block (standard), while the fourth was highlighted with VES imagery. For this event, the pedestrian was highlighted with a vertical green line. All of the events were counterbalanced for the study.

PRTs to the pedestrian were no different across display type and performance improved over the course of the study. When the pedestrian was highlighted with VES imagery, the PRTs were slower than for the non-highlighted pedestrian and an alarming number of drivers did not respond to the enhanced pedestrian. For this event, PRTs for the conformal display were slower ($M = 1.21$ s) than the non-conformal display ($M = 0.95$ s). Twenty-five percent of drivers in the conformal condition and 13% in the non-conformal condition did not respond to the highlighted pedestrian.

This study demonstrated that previously inexperienced enhancement for pedestrians causes an increase in PRT. Several plausible interpretations can be made. First, the green enhancement of the highlighted pedestrian may have obscured the pedestrian. Until a pedestrian is recognized, the appropriate response cannot be made. Participants that missed the highlighted pedestrian mentioned that they were confused how to respond. Thus, visual enhancement should not interfere with the recognition of important targets and hazards in the traffic environment. Second, coupling of rare or unexpected events to proper responses before they are needed in an emergency is a nontrivial problem.

Three guidelines are necessary for enhanced imagery to be useful to a driver: 1) it should increase the likelihood that pedestrians are detected; 2) highlighting should not interfere with object recognition; and 3) how to respond to the threat or hazard should be evident to the driver.

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REFERENCES

- Horrey, W. J. (1999). Vision enhancement in automobiles: The effect of display type on perception-response time. *Unpublished B. Sc. Honours thesis*. Calgary, Alberta: University of Calgary.
- Wickens, C.W. & Long, J. (1995). Object versus space-based models of visual attention: Implications for the design of head-up displays. *Journal of Experimental Psychology: Applied*, 1(3), 179-193.