Psychometric assessment of possible legibility impairment with micro-prismatic retro-reflective materials used for road signs

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Abstract:

Traffic control and guidance signs are made retro-reflective to ensure their visibility at night, when the road scene is only illuminated by the headlamps, based on the idea that the higher the luminance, the better the visibility. In this respect, micro-prismatic sheetings provide performances up to several times that of classic reflective materials. The question then arises whether the luminance might be so high as to actually impair the legibility of the signs, especially when the driver, who is adapted to dark conditions, is suddenly confronted with a very bright object.

This paper addresses the potential dazzling effect of the use of micro-prismatic sheetings for traffic signs. The luminance of a sign strongly depends on illumination and observation conditions, as well as on its retro-reflective properties. It was shown [1] that a driver passing a micro-prismatic regulatory sign on the right side of the road may see the luminance change from between 10 and 20 $cd.m^{-2}$ at 200 meters, to between 60 and up to 200 $cd.m^{-2}$ at 100 meters.

Previous research on temporal visual adaptation in the driving context mainly addresses lighting at tunnel entrances [2-5]. The corresponding experiments are based on the psychophysical staircase procedure, which is however inadequate in the present study, because our goal is to compare different technical systems (micro-prismatic *versus* glass beads) under specific conditions, rather than to estimate a performance threshold.

We propose a standard driving scenario where the driver approaches a regulatory sign on the right side of a straight road, starting from a distance of 300 meters (328 yards), at a constant speed of 90 km/h (55 mph). Hence, the sequence lasts 12 seconds, during which the luminance of the sign changes from less than 10 $cd.m^{-2}$ to more than 200 $cd.m^{-2}$ according to the relative positions of the driver, the dipped headlamps (European low-beam photometric data from UMTRI [6]), and the retro-reflective road sign.

Figure 1. Simulated regulatory road sign (with and without the cut in the Landolt ring).

In our experiment, the scenario is simulated using pre-computed videos, displayed on a calibrated 17" LCD screen, in which the observer seemingly approaches a "zero mph" speed limit sign (see Fig. 1) in controlled temporal geometric and photometric conditions.

At some point in every videos, corresponding to a random distance between the sign and the observer, a break appears in the black ring which represents the zero character, and disappears after 80 ms. The observer is instructed to locate the opening, which randomly occurs at the top, bottom, left or right side of the ring. This task was designed on the basis of the standard Landolt ring test.

Each observer is shown a number of videos for a sign with micro-prismatic technology, and the same number of videos for a sign with glass beads, in a random sequence. The observers were free to comment on any aspects of the current experiment. The experiment was performed in a room of our laboratory which is dedicated to visibility and visualization studies.

From preliminary results based on experimental data from 6 subjects, we see no strong effect of the new technology, as far as visual performance is concerned. However, verbal data indicate that some people find it more unpleasant to stare at micro-prismatic stimuli than at glass beam stimuli, saying that they need more concentration. Thus, the hypothesis that micro-prismatic may increase the visual attention needed for visual detection should be explored with a different experimental paradigm.

In conclusion, beyond this case study, the protocol we propose may be applied to assess road visibility in dynamic conditions which are closer to the actual driving context than the standard visual performance tests.

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