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Evaluation of Emergency Brake Light Display (EBLD) systems

J.W.A.M. Alferdinck

SUMMARY

Purpose: An international discussion on the improvement of the rear stop signals of cars is focussing on a signal for emergency braking, called *Emergency Brake Light Display* (EBLD). EBLD will be additional to the current rear stop lamps and should lead to a more adequate reaction of the road user when the car in front is braking hard. The EBLD systems currently being considered as candidates for regulations are based on switching on (additional) flashing rear lighting signals. By order of the RDW (Vehicle Standards Development) in the Netherlands we have conducted a comparative study.

Methods: We conducted a reaction time experiment with real car lamps in the laboratory. The subject's reaction of the normal braking light signal was compared to four EBLD types, all equipped with filament bulbs. One EBLD consisted of the normal stop lamps flashing at 5 Hz. The other three EBLDs were a combination of the normal stop lamps and additional flashing lamps, i.e., a rear fog lamp flashing at 1.5 Hz or 5 Hz and hazard warning lamps flashing at 1.5 Hz. The signals were presented during a simulated driving task. During half of the presentations there was an additional distraction task that simulated the effect of a short inspection of in-car equipment.

Results: In terms of reaction time, for the conditions with and without distraction task, the performance of none of the emergency braking light signals was significantly better than the normal braking light signal. On the contrary, in the condition with distraction task, the braking light signal with the stop lamps flashing at 5 Hz is worse than the normal braking light signal; the reaction time being 80 ms longer (Fig. 1). In the condition without distraction task no difference in reaction time was found. On average, the distraction task increased the reaction time with 250 ms.

In terms of missed signals, there was a favourable effect of the EBLD with the rear fog lamp flashing at 1.5 Hz. During the distraction task, the percentage of missed signals of this EBLD was 5%, while the percentage missed signals for the normal braking light signal was 15% (Fig. 2). There was no significant difference in missed signals between the normal braking light signal and the other EBLDs. In the condition without distraction task no difference in missed signals was found. On average, the percentage of missed braking signals increased from 0.6% to 11% by adding the distraction task.

The poor performance of the 5 Hz signals can probably be explained by the limited dynamic behaviour of lamps with filament bulbs. Only 80 % of the maximum light output is reached and in the first part of the signal it is even lower. The increment intensity, corrected for this adverse high frequency behaviour, is a good predictor of the performance ranking.

Conclusion: EBLD equipped with incandescent lamps are not effective when they are flashing at 5 Hz. Lower frequencies (1.5 Hz) are only effective in combination with high intensities. Since LED light sources do not suffer from slow rise times it is recommended to include LEDs in further experiments.

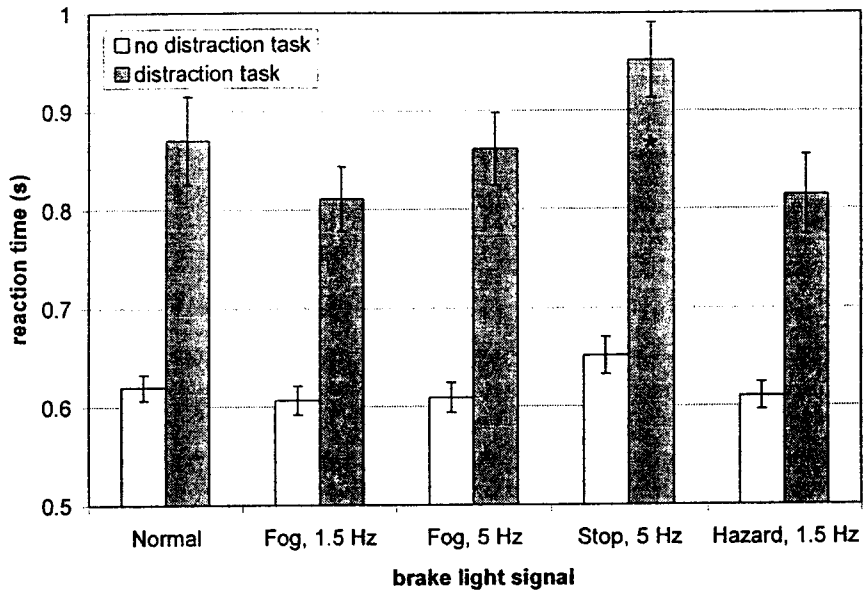

Fig. 1. Average reaction times for the various brake light signals in the condition with and without distraction task. The error bars indicate the standard error of the mean (SEM). * = Significantly different from all other brake light signals, with distraction task.

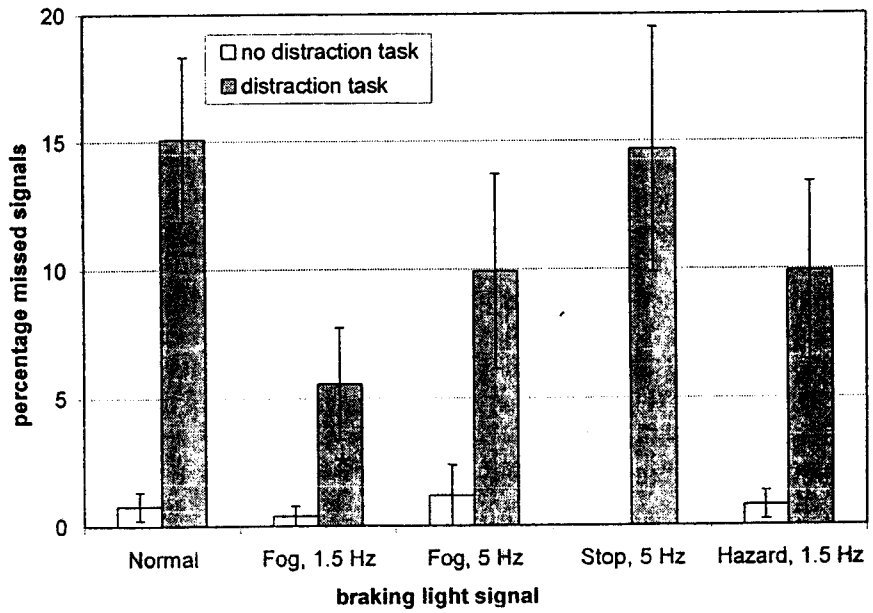

Fig. 2. Average percentage missed braking light signals for the various types of braking light signals in the condition with and without distraction task. The error bars indicate the standard error of the mean (SEM). * = Significantly different from Normal and Stop, 5 Hz, with distraction task.