‘Intuitive’ vibrotactile collision warnings for drivers

Cristy Ho[1], Nick Reed[2], & Charles Spence[1]
[1]University of Oxford, Oxford
[2]Transport Research Laboratory, Wokingham
United Kingdom

Abstract

A study was designed to investigate the possibility of improving driver responses to potential critical emergency situations by implementing vibrotactile warning signals that indicated the likely direction of potential collision events. Normally-sighted participants drove in a driving simulator in which a car following scenario was modelled. The participants were instructed to try and maintain a safe headway distance to the lead car, and they had to respond as quickly as possible to the sudden deceleration of the lead car which had its brake lights disabled. The participants performed the task either with or without the aid of vibrotactile warning signals (presented to their waist) that indicated the direction of potential collision events (front vs. rear). The results demonstrated significantly faster (> 400 ms faster) braking responses and larger (> 3 m) safety margins when the vibrotactile warning signal was presented than when it was absent. These findings therefore demonstrate the potential effectiveness of ‘intuitive’ vibrotactile cues in helping drivers to orient their spatial attention in the appropriate direction and respond appropriately, especially in situations where the effectiveness of visual or auditory driving aids may be impaired. Given the robust benefit attributable to the provision of vibrotactile cues even for drivers with normal vision, the benefits for low-vision drivers are likely to be even greater.

Background

The sense of touch provides a potentially effective, but at present underutilized, alternative to the traditional focus on vision and audition in automobile interface design. In particular, recent research has demonstrated the feasibility of using vibrotactile cues to communicate directional and distance information to drivers via vibrotactile displays embedded in the driver’s seat (e.g., van Erp & van Veen, 2004), worn around their waist (e.g., Ho et al., 2005), or via a vibrotactile display worn on their torso (e.g., van Erp et al., 2004). The rapid growth of interest in the design of tactile applications (see Gallace et al., in press) is supported by robust neuropsychological evidence from studies on the multisensory integration of information available from various different sensory modalities (see Calvert et al., 2004; Spence & Driver, 2004). Given drivers’ frequent complaints regarding visual overload (Sivak, 1996) and the potential benefits of using touch as an alternative or

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