Perfect Timing: Urgency, Not Driving Situations, Influence the Best Timing to Activate Warnings

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Objective: The aim of the study was to investigate the influence of different driving scenarios (urban, rural, highway) on the timing required by drivers from a two-stage warning system, based on car-to-car communication.

Background: Car-to-car communication systems are designed to inform drivers of potential hazards at an early stage, before they are visible to them. Here, questions arise as to how drivers acknowledge early warnings and when they should be informed (first stage) and warned (second stage). Hence, optimum timing for presenting the information was tested.

Method: A psychophysical method was used to establish the optimum timing in three driving scenarios at different speed limits (urban: 50 km/h, rural: 100 km/h, highway: 130 km/h). A total of 24 participants (11 female, 13 male; M = 29.1 years, SD = 11.6 years) participated in the study.

Results: The results showed that the optimum timing did not differ among the three scenarios. The first and second stages should ultimately be presented at different timings at each speed limit (first stage: 26.5 s, second stage: 12.1 s before a potential hazard).

Conclusion: The results showed that well-selected timing for activating information and warning is crucial for the acceptance of these systems. Appropriate timing for presenting the information and warning can be derived for these systems.

Application: The findings will be integrated in further development of assistance systems based on car-to-x technology within the Car2X-Safety project of the Niedersächsisches Forschungszentrum Fahrzeugtechnik in Germany. This study was also supported by Chalmers University of Technology in Sweden.

Keywords: collision warning timing, car-to-car communication, driver assistance, driving scenario, traffic jam, method of adjustment

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INTRODUCTION

The past few decades have seen the greatest development in future vehicles by the implementation of electronic systems and software in vehicles. In particular, the development of advanced driver assistance systems (ADAS) is considered in this study. The main tasks of ADAS are to (a) inform drivers about the vehicle and road/weather conditions (e.g., outside temperature display), (b) support drivers during normal driving conditions (e.g., navigation systems, lane departure warning, speed control), and (c) counteract drivers' mistakes to prevent an imminent accident (e.g., electronic stability control, adaptive cruise control, emergency braking). The aim is to promote safe and accident-free driving. For an overview of different approaches of ADAS, see Bubb (2003); Gründl (2005); Staubach (2009); Vollrath, Briest, and Drewes (2006); Werneke, Kassner, and Vollrath (2008); and Winner, Hakuli, and Wolf (2012).

The two most predominant lines in the development of ADAS have taken place in the past few years: First, the number of in-vehicle information and warning systems has increased rapidly (see, e.g., Lu, Wevers, & van der Heijden, 2005; Tango & Montanari, 2006), as demonstrated by the significant rise in personal vehicles equipped with ADAS. For example, drivers are supported by navigation systems, headway controls, speed controls, and collision avoidance systems (e.g., brake assistance system), and thus, driver errors can be reduced and accidents prevented. In contrast, as the number of in-vehicle systems becomes more common, drivers are exposed to a rising number of warning signals presented at different locations in the cockpit and potential safety risks linked to information overload (Abernethy & Yang, 2000; Hoekstra, 2000). Because of this trend, it is evident that adequate