

# Violating the driver's anticipation of threats and the effect of Forward Collision Warnings

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## Abstract

The effect of different warning modalities for Forward Collision Warning (FCW) systems on driver reactions has been shown in several studies (e.g. Ho, Reed & Spence, 2007; Kiefer et al., 1999). Acoustic and haptic warnings tend to lead to shorter reaction times than visual warnings alone. Past research mainly studied distracted drivers. The focus of this study was the impact of FCW and different levels of situational awareness (Endsley, 1988) on crash avoidance behaviour of attentive drivers. Participants drove in a stationary driving simulator experiencing several situations with imminent frontal collisions. Behaviour of the surrounding traffic was modified to attempt to change the participants' situational awareness. The traffic behaviour allowed the threat to be anticipated (1), not anticipated (2), or by introducing a second but irrelevant traffic stimulus, the driver's anticipation was misled (3). Utilized warning modalities were acoustic, haptic, visual, and as a control, no warning. The main results of this study are that attentive drivers benefit from FCW regardless of the modality, when they cannot anticipate the threat. They benefit the most, when the traffic is misleading their anticipation. The effect does not occur when the threat appears suddenly. The effect of the modality is small. Acoustic and visual warnings tend to be more effective than the haptic one in this setting.

## Introduction

More than 4,000 people were killed in German traffic in 2009 (Statistisches Bundesamt Deutschland, 2010) and more than 41,000 people are killed on U.S. roadways every year in motor vehicle crashes (NHTSA, 2008). Knowledge of the driver's status before a crash may be useful for the development of collision avoidance systems. The driver attentional status is reported in 58.5% of crashes from the Crashworthiness Data System (Stutts et al., 2001). The statistics based on this data suggest that drivers were attentive in 75% of these crashes. Collision avoidance systems for rear-end collisions generally focus on inattention as the cause for crashes. These systems try to focus the driver's attention in the direction of the hazard and evoke an avoidance reaction by some sort of alert (e.g. tone or light). Most of the experiments investigating Forward Collision Warning Systems (FCWS) in traffic situations have been conducted with distracted drivers (e.g. Dingus et al.,