What does the driver look at? The influence of intersection characteristics on attention allocation and driving behavior

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ABSTRACT

One of the main contributing factors with intersection accidents is lack of information due to attention allocation. In many cases, drivers fail to yield right of way to other traffic participants. One reason is that drivers have inappropriate expectations about a traffic situation. They allocate their attention primarily to certain areas of the intersection but neglect others. In a driving simulator study, the influence of intersection complexity on drivers’ expectations and their driving behavior was examined. In two T-intersections, the complexity was varied by the traffic density (low and high) using either one or two important objects: vehicles (left) with or without pedestrians (right). Additionally, the reaction to two critical incidents in close proximity of the intersections was examined. Gaze behavior, vehicle reactions, and subjective data were recorded. 40 subjects (26 male, 14 female, M = 31.0 years, SD = 11.9 years) participated in the study. Interestingly, the least complex intersections showed the most accidents which was interpreted as the result of inadequate attention allocation. It was shown that both the drivers’ attention allocation and vehicle velocity when turning off were responsible for this effect. The results contribute to a better understanding of the role of drivers’ expectation and attention allocation in the causation of intersection accidents.

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1. Introduction

Driving at intersections is one of the most complex tasks for a driver, especially in view of the high density of visual stimuli. Successful driving in those situations requires a large amount of visual and mental resources (Hills, 1980). It requires the correct detection, identification, and assessment of the visual stimuli. Because of the large visual input, more than 90% of these accidents are due to problems with the acquisition of visual information (see, e.g., Hills, 1980; Olson, 1993; Sivak, 1996).

In the 1970s, different “in-depth” accident studies (see, e.g., Clayton, 1971, 1976; Fell, 1976; Sabey and Staughton, 1975; Staughton and Storie, 1977; Treat et al., 1979) were conducted to gain greater details on the circumstances leading to an accident. During the last decades, additional in-depth crash causation analyses (see, e.g., Fuerstenberg, 2005; Graab et al., 2008; Hoppe et al., 2007) enhanced the knowledge about possible reasons for driver errors contributing to accidents. All these accident analyses have shown that one of the major contributing factors is a perceptual error by the drivers. In consequence, drivers have insufficient information about their current driving situation. For example, a recent in-depth accident study (Vollrath et al., 2006) about the involvement of human errors in the causation of car accidents in Germany has found that about 36% of all severe accidents examined (n = 992) happened at intersections. In more than 90% of these intersection accidents, lack of information was the main reason for the drivers’ error leading to an accident. In most cases, it leads to the drivers failing to yield right of way to other traffic participants. Similar results are found in the studies of Graab et al. (2008), Hoppe et al. (2007), and Wierwille and Tijerina (1995).

Looking at reasons for this driver error, most drivers reported that they just did not notice the other traffic participant. In the accident analyses mentioned above, two main reasons for perceptual errors were identified: either drivers looked but failed to see (LBFTS, see Brown, 2005; Cairney and Catchpole, 1996; Herslund and Jørgensen, 2003; Koustanai et al., 2008; Langham et al., 2002; Sabey and Staughton, 1975; Staughton and Storie, 1977) or drivers failed to look, and thus saw the other traffic participant too late to avoid a collision (Staughton and Storie, 1977; see also Hills, 1980; Rumar, 1990). This second kind of perceptual error was found to be especially relevant in bicycle–car accidents as shown in different in-depth surveys in the Nordic countries (see, e.g., Pasanen, 1992; Råsänen and Summala, 1998, 2000; Summala et al., 1996). There it was found that nearly all of the drivers reported not having noticed the cyclist at all. The main reason for that was that drivers did not look into the direction where the cyclist came from. According