



Effects of driving anger on driver behavior – Results from naturalistic driving data [☆]



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ARTICLE INFO

Article history:

Received 11 July 2016

Received in revised form 21 October 2016

Accepted 24 October 2016

Available online 27 December 2016

Keywords:

Driving anger

Driver behavior

Driver distraction

Naturalistic driving

Aggressive driving

ABSTRACT

There is a positive relationship between driving anger and near-crash or crash risk. However, it remains unclear if anger in fact contributes to traffic accidents and whether this happens due to cognitive overload or aggressive driving behaviors. This study investigated how anger affects driving behavior based on naturalistic driving data from the second Strategic Highway Research Program (SHRP 2). Ten-minute trip segments were analyzed in which drivers exhibited anger with regard to driving errors, violations, and aggressive expressions. This data was compared to a matched baseline consisting of the same drivers not exhibiting anger. Results showed that anger resulted in more frequent aggressive driving behaviors but did not increase driving error frequency. Anger consequently creates danger due to deliberate behaviors rather than because of cognitive overload. In congruence with this finding, only anger triggered by threats, provocations, and frustrations increased the frequency of deliberate infringements. In contrast, anger due to having conflicts with someone on the phone or with a passenger was not linked to any type of aberrant driving behavior. Finally, severe displays of anger were accompanied by more violations as compared to slight or marked anger.

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1. Introduction

According to the World Health Organization in 2015, the number of deaths on the road globally plateaued at 1.25 million per year, making road traffic injuries a leading cause of death (Toroyan, 2015). A central factor in crash risk is road user behavior (Rowe, Roman, McKenna, Barker, & Poulter, 2015). Especially inattention and driver distraction due to secondary tasks are among the leading causes of motor vehicle accidents (e.g., Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006; Klauer et al., 2014). Distractions while driving can stem from a competition for visual processing, manual interference, or cognitive sources of distraction, such as speaking with a passenger, conversing on the phone, or in the context of voice control (Strayer, Turrill, Coleman, Ortiz, & Cooper, 2014). It is controversial how cognitive distraction affects driving performance. Some findings suggest that cognitive distraction may impair traffic safety as a result of a diversion of attention (Strayer et al., 2013). However, especially during long drives, it can also reduce the risk of driving errors caused by fatigue (Jellentrup, Metz, & Rothe, 2011). Therefore, it is not surprising that cognitively distracting tasks have been found to be asso-

[☆] The findings and conclusions of this paper are those of the authors and do not necessarily represent the views of the VTTI, SHRP 2, the Transportation Research Board, the National Academies, or the BMW Group, which funded the current work.

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Nomenclature

GLMM	Generalized Linear Mixed Model
LMM	Linear Mixed Model
NDS	Naturalistic driving study
SHRP 2	Second Strategic Highway Research Program
VTTI	Virginia Tech Transportation Institute

ciated with a decreased crash and near-crash risk in several naturalistic driving studies (Hickman, Hanowski, & Bocanegra, 2010; Klauer et al., 2006; Olson, Hanowski, Hickman, & Bocanegra, 2009).

1.1. Driving anger

A particularly interesting special case of cognitive distraction is driving anger. Driving anger is considered to be a situation-specific emotional construct comprised of anger-related feelings and thoughts that occur while driving (Nesbit & Conger, 2011). Cognitive distraction, in turn, is a withdrawal of attention from the processing of information necessary for the safe operation of a vehicle (Strayer et al., 2014). The feelings and thoughts that accompany driving anger are likely to withdraw attention from the driving related information processing. Driving anger can therefore constitute a mental impairment, particularly when it arises in connection with a conversation. Several studies indicate that anger is among the most important factors involved in unsafe driving (e.g., Dahlen, Martin, Ragan, & Kuhlman, 2005). In a survey by Joint (1995), about 90% of 526 car drivers reported that they had been victims of road rage incidents during the past year. Moreover, a recent analysis of naturalistic driving data from the second Strategic Highway Research Program (SHRP 2) found that driving while observably emotionally agitated, for example due to anger, increased the risk of a crash by 9.8 times compared with apparently alert, attentive and sober driving episodes (Dingus et al., 2016).

1.2. Anger and aberrant driving behavior

Even though several studies found a connection between driving anger and increased risk of near-crash or crash events (e.g., Deffenbacher, Deffenbacher, Lynch, & Richards, 2003; Dingus et al., 2016), it is not entirely clear how anger is associated with these situations. It is possible that anger does not even precede them but instead is a result of these events (Underwood, Chapman, Wright, & Crundall, 1999). On the other hand, if anger indeed contributes to traffic injuries, it is unclear whether this happens due to increased cognitive load, leading to unintentional failures, or because of aggressive driving and therefore deliberate unsafe driving behaviors.

It is highly relevant to examine the effects of driving anger on driving behavior, as the behaviors of road users explain much more variance of traffic accidents than do vehicle, roadway, or environment factors (Singh, 2015). In a survey investigating factors leading up to crashes, the driver was found to be the critical reason in about 74% of the crashes due to driving errors or violations (Singh, 2015). These driving behaviors can be referred to as “aberrant driving behaviors” (Zhang, Chan, & Zhang, 2015, p. 124). Until now, aberrant driving behaviors have not received satisfactory attention in studies investigating the impact of driver distraction, particularly in naturalistic driving studies (Young, 2015). Indeed, these behaviors are a crucial factor threatening road safety (Zhang et al., 2015). Distraction risk estimates are likely confounded and erroneously increased when aberrant driving behaviors are not taken into account in driver distraction investigations (Young, 2015).

According to Reason (1990), in order to appropriately assess aberrant driving behaviors it is necessary to distinct between errors and violations. In fact, these behaviors appear to have different psychological origins (Reason, Manstead, Stradling, Baxter, & Campbell, 1990). Errors are defined as unwitting deviations of action from intention or the failure of planned actions to achieve their intended consequence (Reason, 1990; Reason et al., 1990). In contrast, violations are “deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system” (Reason et al., 1990, p. 1316). Thus, in order to investigate the connection between driving anger, driving behavior and near-crash or crash risk, it is necessary to consider both the effect of anger on unintentional cognitive failures and on deliberate infringements of accepted principles of safe driving.

1.3. Anger and aggressive driving

There is evidence that angry drivers engage in deliberate unsafe driving behaviors. For example, Parker, Lajunen, and Stradling (1998) found in a questionnaire study that 89% of 270 drivers admitted committing violations such as chasing other road users or sounding the horn to communicate annoyance to other road users. Indeed, several studies noted that angry drivers engage more often in aggressive and dangerous driving behaviors (e.g., Berdoulat, Vavassori, & Sastre, 2013;

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