

The Current State of Research on Driving Anger

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Abstract: Driving anger is a significant factor in causing traffic accidents and poses a severe threat to road safety. This paper reviews the research progress on driving anger over the past decade, including its definition, research methodologies, influencing factors, and intervention measures. The literature indicates that (1) questionnaires, driving simulators, video recordings, and behavioral diaries are commonly used research methods. (2) The factors influencing driving anger include demographic elements (such as age, gender, alcohol consumption), personality traits (such as anger trait, sensation seeking), and environmental factors (such as road characteristics, life events). (3) To address driving anger, researchers have proposed various intervention measures, including relaxation training, group cognitive behavioral therapy, mindfulness training, and driver re-education programs. These interventions have been somewhat effective in reducing driving anger and aggressive driving behaviors. Future research could further explore the cognitive processes of driving anger and its impact on driving behavior to develop more effective intervention strategies, thereby enhancing road traffic safety.

Keywords: Driving Anger; Research Methods; Influencing Factors; Intervention Measures.

1. Introduction

During the 1990s, the annual average number of traffic accident fatalities in our country was between 60,000 and 80,000, showing an increasing trend year by year. Research from both domestic and international sources indicates that human factors account for 55% to 90% of all accident causes. Researchers have conducted extensive studies focusing on vehicle and traffic system improvements as well as driver education. Frank and others have suggested that emotional and personality factors may influence driving behavior and accident risk (Frank, Bouman, Cain, & Watts, 1992). Building on this, Deffenbacher and others proposed one factor related to driver safety—driving anger (Deffenbacher, Getting, & Lynch, 1994).

2. Definition of Driving Anger

Driving anger is defined as a trait linked to anger characteristics, yet more contextual and specific. Anger traits refer to an individual's tendency to frequently experience anger in particular situations, such as a propensity to feel offended, unfairly treated, or provoked, leading to various negative physiological, psychological, occupational, and social consequences. Driving anger specifically refers to the anger experienced by an individual while operating a motor vehicle, and it represents the intensity of anger within driving-related contexts. The arousal of emotions can affect perception and information processing, thus it is reasonable to believe that anger during driving can directly or indirectly increase the likelihood of risky driving behaviors by influencing attention, perception, information processing, and behavior (Deffenbacher et al., 1994). Due to individual differences, two people in the same situation may exhibit different cognitive and behavioral responses, resulting in diverse expressions of driving anger. Some might react with loud swearing, make offensive gestures, or aggressively maneuver past obstacles; others may scoff and continue to drive safely to prevent negative emotions from causing adverse effects. Although the expressions of driving anger

vary, they can trigger similar physiological responses, such as increased blood pressure and a faster heartbeat. Overall, Deffenbacher and colleagues categorize the expression of driving anger into four types: verbal aggression, physical aggression, expressing anger through the vehicle, and self-regulating anger (Deffenbacher, Lynch, Oetting, & Swaim, 2002).

3. Research Methods for Driving Anger

Current research on driving anger primarily utilizes survey methods, supplemented by driving simulators, videos, and behavioral diaries to gradually explore the predictive relationship between driving anger and aggressive driving behaviors.

3.1. Surveys

Surveys are the most widely used method in the study of driving anger. Deffenbacher and colleagues have developed scales that address driving anger from three aspects: scenarios that provoke driving anger, cognition, and behavioral expression.

3.1.1. Driving Anger Scale (DAS)

This scale includes various scenarios that evoke driving anger, primarily used to test the extent to which specific driving environments provoke anger in drivers. As most scenarios can lead to an experience of anger, a higher score indicates a higher propensity to be provoked. The scale consists of 33 items divided into six dimensions: Hostile Gestures, Illegal Driving, Police Presence, Slow Driving, Discourtesy, Traffic Obstructions. Participants rate their anger on a five-point scale ranging from "not angry at all" (0 points) to "quite angry" (4 points). A condensed version of the DAS, consisting of 14 items, has been developed and shows good reliability and validity in various cultural settings (Ismail, Ibrahim, Rad, & Borhanuddin, 2009; Lajunen, Parker, & Stradling, 1998; McLinton & Dollard, 2010; O'Brien, Tay, & Watson, 2002; Sullman, 2006; Sullman, Gras, Cunill, Planes, & Font-Mayolas, 2007; Yasak & Esiyok, 2009). The

shortened version of the DAS was revised by researchers in China, showing a retest reliability of 0.93; there were no significant differences in scores based on gender, age, or driving experience, although Type A personality individuals scored significantly higher than Type B (Fengzhi, Changji, & Chenglie, 2003).

3.1.2. Driving Anger Expression Inventory (DAX)

The intensity of anger is not the only significant variable in understanding the negative impacts of anger and its relation to other critical behaviors; how people express and manage anger is equally important. The DAX is designed to differentiate how people express anger while driving. It includes 49 items where participants rate on a four-point scale from 1 (almost never) to 4 (almost always) how frequently they use various methods to express anger. The methods of expressing driving anger categorized in the inventory are Verbal Aggressive Expression, Personal Physical Aggressive Expression, Use of Vehicle to Express Anger, and Adaptive/Constructive Expression (Deffenbacher, Lynch, et al., 2002). The inventory has been revised by researchers in Turkey, Spain, Romania, and France, with no current Chinese version (Eşiyok, Yasak, & Korkusuz, 2007; Herrero-Fernández, 2011; Paul Sârbescu, 2012; Villieux & Delhomme, 2010).

3.1.3. Driver's Angry Thoughts Questionnaire (DATQ)

The driving context is a unique environment, and measuring angry cognitions in this context helps to understand driving anger and related phenomena. The DATQ primarily assesses angry cognitions during driving, containing 65 items divided into five dimensions: judgmental and disbelieving thinking (JD), which mainly involve questioning others and their driving behaviors; pejorative labeling and verbally aggressive thinking (PLVA), which include more negative and harsh evaluations and thoughts about how angry one feels and the desire to verbally attack; revenge and retaliatory thinking (RR), which include notions and intended actions of revenge and retaliation; physically aggressive thinking (PA), which involve desires to physically harm others; and coping self-instructions (CSI), emphasizing positive, adaptive thinking such as calming and relaxing behaviors and a tolerant view of the current situation (Deffenbacher, Petrilli, Lynch, Oetting, & Swaim, 2003).

3.2. Driving Simulators

In the research of driving anger, researchers utilize driving simulators to create various road environments and events to induce driving anger and aggressive driving behaviors. In a study by Stephens and colleagues, 96 licensed drivers were randomly divided into four groups, with each group consisting of 12 male and 12 female participants. Participants had 20 minutes to familiarize and adapt to the driving simulator. Then, one group was required to complete a forced following task over three 0.5-mile segments, by adjusting the speed and position of the vehicle ahead to force the driver into a following state. The control group was not subjected to any front vehicle constraints. The average time to complete this simulated route was 15 minutes, whereas the time-pressure group was required to complete the entire driving task within 13 minutes under a countdown, unlike the control group which had no time constraints. Driving anger levels were assessed using scales before and after the task, with heart rate and recordings as evaluation indicators during the task. The results showed that both driving scenarios effectively induced driving anger (Stephens & Groeger, 2011). In further research

in 2013, Stephens and others used the driving simulator along with an eye-tracker to examine differences in subjective anger feelings, eye movement patterns, and driving behaviors (speed, reaction time) among 24 experienced drivers who were university staff and students, under intermittent and continuous interference driving conditions (Stephens, Trawley, Madigan, & Groeger, 2013).

Additionally, Philippe and colleagues investigated the mediating role of driving anger between compulsive enthusiasm and aggressive driving behaviors. Forty-four passionate male drivers aged 18-35 were tasked to complete a simulated driving task alone, being informed that other drivers were also on the same road. Events that could evoke driving anger and aggressive behaviors were introduced during the drive. A camera setup recorded the participants' verbal and behavioral responses, and participants were asked to report their subjective experiences of anger after completing the drive (Philippe, Vallerand, Richer, Vallières, & Bergeron, 2009). Currently, driving simulators are mainly used to explore the predictive role of driving anger emotions on aggressive driving behaviors (Roidl, Siebert, Oehl, & Höger, 2013; Schwebel, Severson, Ball, & Rizzo, 2006).

3.3. Other Research Methods

In addition to surveys and driving simulators, videos and recordings are also used to evoke driving anger. In an assessment of the effectiveness of driving anger cognition using driving situation videos, Nesbit and colleagues had 98 student drivers watch videos from the driver's perspective, divided into three categories. Each category contained six segments ranging from 25 to 30 seconds in length. Participants were asked to imagine themselves driving and complete scales on cognitive biases, emotional experiences, attitudinal biases, and aggressive tendencies after viewing. The video categories included: scenarios provoking anger, such as a large truck moving slowly ahead with a large SUV closely following in the rearview mirror; challenging scenarios like driving on a rainy night while searching for a friend's house; and normal scenarios featuring evening city road driving with occasional traffic situations (Nesbit & Conger, 2011). Suhr and others used a 1.5-minute video to evoke the driving state in participants, who were asked to imagine themselves driving in the right lane with an SUV aggressively tailgating behind them. After watching, participants assessed the video's vividness and their level of anger (Suhr & Nesbit, 2013). Researchers also utilized video materials to study the impact of time pressure on speed perception and perceived duration in driving scenarios, indicating the effects of time pressure on driving safety (Cœugnet, Miller, Anceaux, & Naveteur, 2013).

Previous studies have also employed behavioral diaries as a research tool. Underwood required 100 British drivers aged 17 to 42 to record details of every trip made over two weeks, including the date, distance, duration, severity of any incidents and a brief description, the degree of driving anger and its impact on driving behavior, and descriptions of other road users' benevolent actions. This data was used to analyze possible causes of driving anger and its counteractive effects on driving behavior (Underwood et al., 1999).

4. Influencing Factors of Driving Anger

The anger experienced by drivers depends on two aspects:

the characteristics of objective conditions (such as road features, driving environment, life events, cultural background) and personal factors of the driver (such as age, gender, personality traits).

4.1. Demographic Factors

Currently, the demographic factors widely studied in relation to driving anger include age, gender, and alcohol consumption. Additionally, regional differences among drivers have also been noted.

Lonczak and colleagues surveyed 785 licensed drivers (65% male), of which 55% belonged to a high-risk group with multiple violations, to study the gender differences in general risk factors like driving anger. The results showed that gender significantly correlated with two components of the Driving Anger Scale (DAS)—traffic obstacles and violations—with women scoring higher than men; younger drivers also reported more driving anger (Lonczak, Neighbors, & Donovan, 2007). However, Bachoo and others found no significant gender or age differences in DAS scores after surveying 306 licensed graduate students (Bachoo, Bhagwanjee, & Govender, 2013). Sigve Olstedal's study on the influence of personality traits and gender on risky driving behaviors and accident involvement, which included data from 1,356 youths (724 females) who had been licensed for over three months (mostly aged 18 and 19), also did not show gender differences in driving anger (Olstedal & Rundmo, 2006). Moreover, Lonczak's research indicated that driving anger was significantly positively correlated with the frequency of drinking and significantly negatively correlated with the total amount of alcohol consumed, with more pronounced effects among women (Lonczak et al., 2007).

Deffenbacher focused on the relationship between driving anger, anger expression, aggressive behavior, and risky behavior among drivers of different genders and regions (urban/rural). After comparing students with driving experience from an urban university (50 males, 50 females) and a rural university (50 males, 50 females), it was found that the main effect of the region (urban/rural) on driving anger scenarios was significant. Urban university students reported less driving anger than rural university students, and urban males reported less driving anger than other groups, but the main effect of gender was not significant. There were no differences in the methods of expressing driving anger based on gender or region (Deffenbacher, 2008).

4.2. Personality Traits

4.2.1. Trait Anger

Driving anger is a manifestation of trait anger but is more specific and situational, hence the relationship between driving anger and trait anger has been extensively studied. Stephens and others used a driving simulator to conduct simulated driving tests for 48 licensed drivers across different scenarios. They found that subjects with a tendency towards anger experienced greater levels of anger and frustration; in scenarios with low anger provocation, subjects with higher anger tendencies experienced more severe anger and frustration, drove faster, and exhibited more lateral movements. Regardless of the scenario, even those not considered provocative by others, subjects with high anger tendencies evoked driving anger and displayed aggressive behavior (Stephens & Groeger, 2009).

Deffenbacher and colleagues examined the relationship between the expression of driving anger and trait anger. They

surveyed 330 individuals aged 16-60 and found that scores for verbal aggression, physical aggression, and expressing anger through the vehicle were significantly positively correlated with trait anger scores; self-regulation of anger scores were significantly negatively correlated with trait anger scores (Deffenbacher, Kemper, & Richards, 2007). This shows that an individual's trait anger not only influences the provocation and intensity of driving anger but also affects how people choose to express it.

4.2.2. Sensation Seeking

Research indicates that the expression of driving anger is related to sensation seeking. Bachoo and others surveyed 306 licensed graduate students and found that scores on the Driving Anger Expression Inventory were significantly positively correlated with scores on the sensation seeking scale (Bachoo et al., 2013). Dahlen's research on predicting aggressive and risky driving behavior assessed sensation seeking, impulsiveness, boredom, expression of driving anger, aggressiveness, and risky driving behaviors in 224 college students. They found that sensation seeking, impulsiveness, and boredom had a higher predictive power for the expression of driving anger than scores on the DAS (Dahlen, Martin, Ragan, & Kuhlman, 2005). Whether or not corresponding behaviors occur after the provocation of driving anger, sensation seeking plays a role.

Current research focuses on the predictive power of sensation seeking for aggressive and risky driving behaviors. It is suggested that individuals with a tendency towards sensation seeking exhibit more risky driving behaviors (Iversen & Rundmo, 2002). The combined effect of sensation seeking and driving anger on aggressive driving behavior is still under investigation, including whether there are mediating variables involved.

4.2.3. Big Five Personality Traits

Personality factors not only affect the emergence and intensity of anger but also largely determine the ways in which driving anger is expressed. Numerous researchers have used the Big Five personality model to analyze the relationship between personality traits and the expression of driving anger. Paul Sârbescu had 230 participants aged 20-40 fill out the Driving Anger Expression Inventory and the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ). He found that two factors from the Big Five personality traits—aggression-hostility and impulsive sensation-seeking—were significantly positively correlated with the expression of driving anger, while other factors showed no significant correlation with driving anger expression (Paul Sârbescu, Costea, & Rusu, 2012).

Jovanovic conducted a survey of 260 Serbian drivers aged 16-80, analyzing scores from the UK DAS, DAX, and the Big Five personality scales. The study suggested that neuroticism, agreeableness, and conscientiousness were significantly related to driving anger and aggressive expression. Extraversion was significantly negatively related to the total DAS score and physical aggression expression but positively related to self-regulating anger. The relationship between neuroticism and aggressive driving was mediated by driving anger, but conscientiousness had a direct or indirect relationship with aggressive driving behavior (Jovanović, Lipovac, Stanojević, & Stanojević, 2011). Other researchers have also confirmed that scores on the DAS are significantly negatively correlated with the emotional stability dimension of the Big Five, indicating that more emotionally stable individuals are less likely to evoke driving anger (Dahlen &

White, 2006).

4.2.4. Other Factors

There are other personality factors related to driving anger, including traits like forgiveness, passion, and normlessness. Moore and others had 316 college students complete the Trait Forgiveness Scale (TFS), Consideration of Future Consequences (CFC) scale, Driving Anger Scale (DAS), and Driving Anger Expression Inventory (DAX). Their analysis revealed that the trait of forgiveness was significantly negatively correlated with the total driving anger score and the three aggression-related components of the driving anger expression, but positively correlated with the self-regulation of anger component. The consideration of future consequences trait was significantly negatively correlated with the personal attack and expressing anger through the vehicle components, but positively correlated with self-regulation of anger (Moore & Dahlen, 2008). This suggests that individuals who are inclined to be forgiving and considerate of consequences tend to employ self-regulation to cope with driving anger.

Falco surveyed 1,126 Italian high school students who ride bicycles to identify factors affecting risky driving behavior among cyclists. The results indicated that the cyclists' levels of driving anger were not related to risk perception, driving optimism, or social norms (Falco, Piccirelli, Girardi, Dal Corso, & De Carlo, 2013). Iversen found in a survey of 2,650 Norwegian drivers that individuals with high scores in normlessness were more likely to exhibit aggressive driving behaviors, such as speeding and rule-breaking (Iversen & Rundmo, 2002). Current research has not clarified whether normlessness directly influences aggressive driving behavior or if it is mediated by driving anger, thus the relationship among these three variables remains to be further elucidated.

In research by Philippe and others about passion and aggressive driving behavior, it was found that in experimental driving situations inducing frustration, aggressive driving behavior was related to obsessive passion but not to harmonious passion. In such frustrating driving situations, driving anger served as a mediating variable between obsessive passion and aggressive driving behavior, but was unrelated to harmonious passion (Philippe et al., 2009).

4.3. Environmental Factors

Apart from the personal characteristics of the drivers, objective driving conditions such as road features and non-driving related events also play a role in eliciting driving anger.

Stephen and colleagues induced anger in participants through two scenarios: time pressure and being forced to follow a slow-moving vehicle. Their study with 96 licensed drivers showed that both driving scenarios effectively provoked driving anger, and the combination of time pressure and slow following increased anger levels the most (Stephens & Groeger, 2011).

McLinton and others explored the relationship between work-related stress from effort-reward imbalance and driving anger. In a survey of 215 full-time workers in Nagoya, Japan, they found that experienced work stress was significantly positively correlated with levels of driving anger; higher levels of driving anger were also associated with lower life satisfaction among participants (McLinton & Dollard, 2010). Hoggan and Dollard also suggested that work-related Effort-Reward Imbalance (ERI) could increase driving anger through the mediating variables of general anger and

overcommitment (Hoggan & Dollard, 2007).

Herrero-Fernández analyzed the relationship between driving anger and aggressive driving in both general and driving-specific scenarios among 198 licensed drivers aged 19-73. The results showed no significant differences in anger expression between general and driving conditions (Herrero-Fernández, 2013).

4.4. Cultural Differences

Different cultural environments influence the way people perceive things, which in turn affects their goal setting and behavior choices in practice.

In terms of scenarios that provoke driving anger, participants from New Zealand scored significantly higher on all dimensions of the DAS than participants from the UK but lower than those from the USA (Sullman, 2006). Japanese drivers scored significantly lower on the DAS and its sub-scales compared to drivers from the USA and Australia, with no significant differences compared to UK drivers. However, Japanese participants scored significantly lower on dimensions of rude behavior, traffic violations, and slow driving than UK participants, but higher on hostility and police presence (McLinton & Dollard, 2010). This indicates significant differences in the scenarios that provoke driving anger between Asian and Western cultural backgrounds, with Asian participants more likely to experience driving anger in targeted driving scenarios.

Regarding coping strategies for driving anger, male drivers aged 21-30 in Turkey reported more "physical aggression" and "expressing anger through the vehicle," while female drivers used more "self-regulation of anger." Spanish participants showed no gender differences in these behaviors (Eşiyok et al., 2007; Herrero-Fernández, 2011). In Romania, although younger drivers scored higher on "expressing anger through the vehicle" and overall indices of aggressive driving expression than older drivers, they scored significantly lower on "self-regulation of anger." In Spain, age was significantly negatively correlated with scores on all sub-scales of driving anger expression (Herrero-Fernández, 2011; Paul Sârbescu, 2012).

5. Intervention Measures for Driving Anger

Researchers internationally have employed various interventions for subjects assessed with high levels of driving anger, such as group cognitive-behavioral therapy, relaxation training, and driver re-education programs, and have compared the effects of these interventions.

5.1. Relaxation Training

Deffenbacher and colleagues screened students scoring above 52 on the Driving Anger Scale (DAS), identifying them as a high driving anger group. The participants were randomly assigned to three groups: relaxation training (16 people), cognitive-relaxation training (17 people), and no intervention (22 people). Assessments of driving anger levels were made before the intervention, after the intervention, and four weeks post-intervention. The results showed that both intervention methods significantly reduced participants' tendencies towards anger and driving anger compared to the control group. There was a reduction in hostile and aggressive driving anger expressions and an increase in self-regulation of driving anger. Additionally, cognitive-relaxation training also

reduced the frequency of risky behaviors (Deffenbacher, Filetti, Lynch, Dahlen, & Oetting, 2002).

5.2. Group Cognitive Behavioral Therapy

Strom et al. conducted a group cognitive-behavioral intervention for nine male veterans with aggressive and risky driving behaviors, consisting of eight sessions. Participants completed self-reports before the intervention, after the intervention, and one month post-intervention. Compared to baseline, 88.9% of participants showed a significant reduction in driving-related aggressive behavior, and 66.7% showed a significant decrease in driving-related anger, indicating the effectiveness of group cognitive-behavioral therapy in reducing driving-related anger, aggression, and risky driving behaviors among veterans. However, the study had limitations in terms of sample size and participant group, and the absence of a control group somewhat affected the reliability of the results (Strom et al., 2013).

5.3. Mindfulness Training

Kazemeini and others randomly divided 20 local Iranian taxi drivers into two groups to undergo group cognitive-behavioral therapy and mindfulness training based on cognitive therapy. Results indicated that mindfulness training was more effective than group cognitive-behavioral therapy in significantly reducing driving anger and its aggressive expressions, and in significantly increasing the expression of self-regulation of driving anger. Mindfulness training focuses on the interaction between emotions and cognition, aiming to change the relationship between individuals and their thoughts, helping individuals to distinguish between beliefs and facts, thus weakening negative beliefs without deliberate identification. Researchers believe that mindfulness training based on cognitive therapy is more effective in reducing driving anger and aggression than group cognitive-behavioral therapy alone (Kazemeini, Ghanbari-e-Hashem-Abadi, & Safarzadeh, 2013).

5.4. Driver Re-education Programs

Drivers who violate traffic regulations are often required to undergo re-education. af Wählberg assessed the effectiveness of these re-education programs in improving problematic driving behaviors. Drivers under 25 years of age with high aggression, high stress, high sensation-seeking, high driving conflict, and high levels of drunk driving underwent an online re-education program called the Young Driver Scheme (YDS) for 28 days, with a control group set for comparison. Six months after the intervention, drivers reported higher levels of aggression, stress, sensation-seeking, drunk driving, and driving conflict than before, but lower than the control group. The researcher explained the increase in the intervention group's metrics as due to a decrease in social desirability bias as the re-education progressed, leading participants to answer more truthfully; the difference between groups highlighted the effectiveness of the YDS re-education program. This study also highlights the impact of social desirability on research using self-report methods (af Wählberg, 2010).

6. Summary and Outlook

While driving anger is a widespread phenomenon that threatens driving safety, defining it has proven to be quite challenging. The difficulty lies in the fact that driving anger can manifest both as an emotion and a trait. Thus, providing a clear operational definition that includes specific

manifestations of driving anger is effective.

Internationally, research on driving anger has shifted from a singular focus to a broader model that includes human and environmental factors, driving anger, and aggressive driving behavior. As understanding of driving anger deepens, the focus of research is likely to shift away from the triggers and expressions of driving anger to the cognitive processes that influence it. Future research could explore the relationships between the triggers, expressions, and cognition of driving anger to better explain and intervene in these behaviors.

The ongoing exploration of driving anger ultimately aims to mitigate its negative impacts on driving safety, a topic that will continue to be a focal point for researchers. Existing studies have applied traditional cognitive-behavioral therapy, relaxation training, and mindfulness training to intervene with individuals with high driving anger, achieving some success. Moving forward, in addition to these traditional methods, integrating emerging technologies such as machine learning and affective computing could become a significant area of development. Machine learning algorithms can analyze driver behavioral and physiological data in real time to identify triggers and manifestations of anger. Affective computing could monitor drivers' emotional states in real time through facial recognition and voice analysis. When the system detects anger, it can initiate interventions such as auditory cues or automatic adjustments to the vehicle environment to help alleviate the driver's mood.

Moreover, the use of driving simulators can further enhance the effectiveness of interventions. By setting realistic driving scenarios and coping strategies in simulators, drivers can practice emotional management skills in a safe environment and receive immediate feedback and guidance. This combined approach of using traditional intervention methods with emerging technologies not only improves the timeliness and effectiveness of interventions but also offers personalized solutions to drivers, ultimately aiming to achieve higher levels of road safety.

Future research should focus on how to effectively integrate these technologies and assess their application in real driving environments. By continuously innovating and improving intervention strategies, there is hope for significant progress in enhancing driving safety and creating a safer traffic environment for all drivers.

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