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# A Mini Review of Driving Anger: Research, Potential Challenges and Future Directions

**Wenhui Xi[1], Chenzhao Zhai[2]* and Weihong Kong[2]**

[1]*The Faculty of Mechanical and Transportation, Southwest Forestry University, Kunming, China*

[2]*Institute for Transport Studies, University of Leeds, United Kingdom*

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***Corresponding author:** Chenzhao Zhai, Institute for Transport Studies, University of Leeds, United Kingdom

**Abstract**

This mini review focuses on recent developments, potential challenges and future directions in the field of driving anger research, involving measurements of driving anger, influencing factors of driving anger, and established interventions for reducing driving anger. Moreover, possible challenges and avenues for future driving anger studies are also discussed, including measuring and understanding driving anger in the context of automated driving, the importance of understanding the dynamics of drivers' cognitive appraisal while meeting anger-provoking situations and developing personalised interventions for targeting driving populations. By presenting these preliminary views, it expects to promote further discussion and inspire deeper insights into the field of driving anger.

**Keywords:** Mini Review; Driving Anger Research; Challenges and Future Directions

**Abbreviations:** DAS: The Driving Anger Scale; MAD: The Measure for Angry Drivers; DAX: The Driving Anger Expression Inventory; DATQ: The Driver's Angry Thoughts Questionnaire; BDAQ: The Beliefs about Driving Anger Questionnaire

## Introduction

Driving anger, characterised by anger-related feelings and thoughts specific to driving situations, is a widespread phenomenon that significantly influences drivers' behaviours and road safety [1,2]. Over the past thirty years, numerous researchers explored and investigated the field of driving anger, particularly following the advent of the Driving Anger Scale (DAS) [3]. The present review aims to provide a concise and introductory perspective in the field of driving anger research, indicating its recent advances, potential challenges and future avenues. By presenting these preliminary views, it expects to promote further discussion and inspire deeper insights into the field of driving anger.

## Review of the Driving Anger Research

### Measuring Driving Anger: Propensity, Expression and Thoughts

#### Driving Anger Propensity: Trait driving anger

The DAS, developed by Deffenbacher, Oetting [3], aims to assess the driver's trait driving anger (the propensity to experience anger behind the wheel). The original long version of the DAS consists of 33 items, categorised into six broad anger-provoking situations: hostile gestures, illegal driving, police presence, slow driving, discourtesy, and traffic obstructions. Drivers are asked to imagine encountering these scenarios and rate the intensity of anger provoked by each item. During the past thirty years, the DAS has been widely applied across diverse driving cultures and populations, demonstrating its utility in assessing trait driving anger within the cross-culture context. However, some studies have demonstrated that potential redundancy might exist in the DAS. For example, researchers consolidate factors into "progress impedance" when the six-factor structure is not consistently replicated [4,5]. Also, strong correlation coefficients between sub-scales have been observed, e.g., slow driving anger traffic obstructions [6]. The short version of DAS, deriving from the long version, has 14 items. However, there is no common consensus regarding the factorial structure of the short version of DAS. For example, different factorial structures of the short form DAS have been reported, even if these studies were conducted in the same country [7-9]. It has been suggested that a three-factor solution may be more appropriate for the trait driving anger assessment [10], which reflects common anger sources while driving, including 1) progress impediment, referring to the driver's driving

Wenhui Xi and Chenzhao Zhai contributed equally to this manuscript.

being obstructed, e.g., traffic congestions; 2) being put at risk, reflecting by other road users' risky and dangerous behaviours causing anger; 3) discourtesy, including discourteous actions performed by other road users, e.g., aggressive honking. Recently, the Measure for Angry Drivers (MAD) has been developed, and it is regarded as an alternative measurement for trait driving anger. The MAD integrates various sources for items' development, and they have been reworded to reflect contemporary driving contexts [11]. The MAD consists of 23 items with three factors (danger posed by others, travel delays and aggression from others), in accordance with the proposition by Deffenbacher, Stephens [10]. More recently, MAD has been comprehensively evaluated, demonstrating its applicability across the diverse demographic backgrounds of drivers [12]. However, there is limited understanding of how the MAD performs in assessing trait driving anger across different countries.

**Driving Anger Expression**

Drivers might not only become angry while driving, but they could also express their anger in adaptive and aggressive ways. The Driving Anger Expression Inventory (DAX) is designed to assess how drivers express their anger while facing annoyed situations [13]. Originally, this questionnaire included 53 items across five sub-scales: verbal aggressive expression (e.g., "I make negative comments about the other driver aloud."), personal physical aggressive expression (e.g., "I try to get out of the car and have a physical fight with the other driver."), use of vehicle to express (e.g., "I flash my lights at the other driver."), displaced aggression (e.g., "I take my anger out on other people later on.") and adaptive expression (e.g., "I try to think of positive things to do."). Drivers are asked to report the frequency with which they exhibit each item under different types of anger expression. To be noted, the commonly used version of DAX retains four factors with 49 items (49-DAX), excluding the displaced aggression sub-scale, due to its low reliability [14]. However, displaced aggression is an important form of aggressive expression, which refers to the display aggression towards an innocent target instead of against the original provocateur [15]. More recently, Herrero-Fernández and Bogdan- Ganea [16] developed the displaced aggression questionnaire within the traffic context, providing a promising tool to understand displaced aggression while meeting anger-provoking situations. Despite this, it has been criticised that the 49-DAX might be still long when investigating drivers' anger expression constructs conjunctive with other psychological scales, though it has been widely validated across countries [17-20]. Additionally, it appears that the personal physical aggressive expression sub-scale of the 49-DAX is not well-applicable among drivers, because some researchers removed or integrated these contents when conducting factorial analysis [20, 21]. Subsequently, short forms of DAX were developed, resulting in 15 items DAX and 25 items DAX [22]. Both short versions of DAX retained four sub-scales, consistent with the 49-DAX. More recent studies employed short forms DAX [23, 24], showing their capabilities in assessing drivers' anger expressions. The four-factor structure of the short forms of DAX has been replicated in Western countries [25, 26]. However, it appears that the research conducted the Eastern driving culture tends to combine aggressive anger expressions into a similar factor [23, 24].

**Driving Anger Thoughts**

Negative/angry thoughts and beliefs might lead to negative emotional responses and aggressive actions, which play a crucial role in influencing individuals' behavioural tendencies [27]. Driving anger thoughts refer to thinking styles that occur when drivers meet anger-eliciting events behind the wheel, as measured by the Driver's Angry Thoughts Questionnaire (DATQ) [28]. The original DATQ is composed of five subscales with 65 items, including judgmental thinking (e.g., "How did that person get a license?"), pejorative labelling and verbally aggressive thinking (e.g., "What a stupid driver!"), revenge/retaliatory thinking (e.g., "I'm going to get revenge."), physically aggressive thinking (e.g., "I want to kill them."), and coping self-instructions (e.g., "Just calm down."). Respondents are asked to report how often they experience each of the thoughts presented in the questionnaire. Compared to other instruments for assessing constructs of driving anger, there are fewer studies validating drivers' thinking styles in anger-evoking contexts [29]. To the best of the authors' knowledge, to date, roughly twenty studies have validated the factorial structure of the DAS (either long or short forms), and approximately fifteen studies have validated the factorial structure of the DAX (either long or short forms). However, less than ten studies (i.e., approximately six studies) have assessed the psychometric properties of the DATQ. This may be due to its length, which requires larger sample sizes for validation and restricts its ability to be used in conjunction with other instruments. In addition to the DATQ, some interesting standpoints have also been proposed recently to assist in understanding drivers' thoughts while experiencing annoying triggers. For instance, Love, Kannis-Dymand [30] developed the Beliefs about Driving Anger Questionnaire (BDAQ) to evaluate drivers' thoughts and beliefs through the metacognitive perspectives, which can be regarded as a higher-order process for regulating and monitoring lower-order interplay between cognition and emotions [31]. This instrument consists of 20 items with five sub-scales: positive beliefs about the utility of anger (e.g., "My anger helps me focus on what's important on the road when driving."), positive beliefs about the utility of rumination (e.g., "I need to ruminate on past angry driving experiences so that I am prepared for similar events in the future."), negative beliefs about the constructability of anger (e.g., "When I am angry at another driver, my anger quickly becomes out of my control."), negative beliefs about the controllability of rumination (e.g., "I cannot stop myself from thinking about revenge following a negative driving event."), antisocial beliefs about anger expression (e.g., "My angry behaviour towards other


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drivers is usually justified."). These maladaptive thoughts are moderately and positively associated with aggressive forms of anger expression [30]. In summary, trait driving anger and driving anger expression have been widely investigated in comparison with drivers' angry thoughts. The psychometric properties of recently updated measurements for assessing driving anger should be examined further across different countries. In terms of understanding drivers' angry thoughts, the validation of the DATQ seems necessary, which could be beneficial for the development of cognitive interventions. What's more, assessing recently developed measurements (i.e., BDAQ) could provide additional information in controlling drivers' rumination and beliefs.

## Understanding Influencing Factors of Driving Anger

To manage driving anger, Sharkin [32] suggested focusing on drivers' demographic characteristics (e.g., age and gender), dispositional traits and situational factors. Regarding demographic background, age and gender differences have been widely investigated, but the results are inconsistent. Specifically, some studies found that young drivers are more likely to become angry while driving [5, 6, 33], whereas no associations between age and trait driving anger were also disclosed by several studies [9, 34, 35]. In addition, literature generally acknowledges that young drivers tend to express their anger in more aggressive formats than older drivers [19, 21, 22, 36]. With respect to the gender differences, most studies reported that males and females demonstrated a similar tendency to experience anger while driving [10], but some gender differences were detected when separately examining subscales of the DAS (long version). For example, males show a higher inclination to become angry when facing slow driving situations than females [37]. Whereas females reported more trait driving anger when meeting discourtesy, hostile gestures [34, 38], and illegal driving [39, 40]. When considering gender differences in drivers' anger expression, it has been found that males tend to express anger in personal physical and using vehicle expression compared to females [21, 22, 24, 41, 42], and females tend to deal with anger expression in adaptive forms in comparison with males [25, 36, 43, 44]. Interestingly, there are no significant differences in verbal aggressive expression between males and females [20, 41, 45]. Regarding angry thoughts, it is unclear its relationship with age, existing research indicated that younger drivers reported a greater frequency engage in all aggressive thoughts compared to older drivers, or age has no or weak association with drivers' angry thoughts [29, 46, 47]. With respect to gender differences, males retained more judgmental, revengeful and physically aggressive thinking than females [28, 47, 48], but also, some studies suggested that males and females showed no difference in verbally aggressive thinking and coping self-instructions [28, 46].

Various dispositions have been examined in their relationship with drivers' trait driving anger and anger expression previously. For instance, trait anger (i.e., an individual's general tendency to become angry) and sensation-seeking (i.e., a need to experience novelty, excitement, and dangers) have been widely investigated [3, 49-55], indicating their role in increasing angry propensity and aggressive anger expression. It appears an increasing interest in exploring the influences of gender roles and the HEXACO personality traits in driving anger in recent years. Among these studies, masculinity is found to be positively related to trait driving anger and aggressive anger expression [56, 57], whereas femininity is positively associated with adaptive anger expression [42, 57, 58]. Regarding the HEXACO personality traits, Emotionality appears to be associated with an increase in trait driving anger [59], whereas Honesty-Humility is negatively related to angry propensity and aggressive anger expression [24].

It has been highlighted that situational factors are important triggers for eliciting anger while driving [60]. In essence, the appraisal theory explicitly describes how individuals interact with the external environment which is related to personal desires and goals [61, 62], providing the link between the surrounding context and personal well-being. According to the perspective of the appraisal theory [63], anger might be experienced by evaluating 1) whether the surrounding situation is related to and conflicts with personal desires and goals, and 2) the potential resources and perceived ability to cope with the stressor. By using events recall and imaginary approaches, drivers' cognitive patterns when confronting anger-provoking situations have been explored in different countries [56, 64, 65], indicating excessive culpability and perceived high coping potential are associated with the anger intensity. Also, these studies suggested that the effects of drivers' cognitive appraisal on anger are stronger compared to dispositional traits, e.g., trait driving anger. More recently, it has been revealed that individual characteristics (e.g., gender, dispositions) could influence drivers' appraisal, suggesting the importance of concurrently considering both non- cognitive factors and cognitive factors when understanding driving anger [65].

In summary, drivers' demographic background has been widely reported, gender differences might be salient when examining trait driving anger in specific anger-provoking situations. Studies focused on drivers' angry thoughts are comparatively less, resulting in limited understanding between drivers' characteristics and their thoughts retained while meeting driving anger events. Interestingly, gender roles, the HEXACO personality traits and drivers' cognitive appraisal have been recently focused by researchers, providing valuable insights to understand driving anger.

## Interventions for Reducing Driving Anger

Deffenbacher [66] provided a comprehensive review of interventions used for driving anger, which is useful when designing strategies for regulating driving anger. Recently, some interventions have been conducted among different driving populations in a group-based and long formats. For example, Kazemeini, Ghanbari-e-Hashem-Abadi [17] assessed the effect of mindfulness-based cognitive intervention in treating driving


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anger among male Iranian taxi drivers, findings showed that drivers' trait driving anger and aggressive expressions of anger could be reduced. Besides, Feng, Zhan [67] conducted the cognitive intervention and forgiveness intervention among male Chinese bus drivers, they found that both interventions are effective in reducing drivers' trait driving anger and aggressive anger expression. Moreover, Haustein, Holgaard [68] designed a brief version of cognitive-behavioural intervention among Danish drivers. After receiving the intervention, drivers reported more adaptive anger expression, but there was no significant improvement in driving performance in the context of the simulated driving. Eisapareh, Nazari [69] aimed to reduce driving anger among male Iranian taxi drivers. The finding suggested that those who received the intervention in a face-to-face format experienced a more prolonged effect in reducing trait driving anger and self-reported aberrant driving behaviours compared with the online format intervention. Other recent interventions employed vehicle-based tools for reducing driving anger. For instance, Li, Zhang [70] compared how different comments' styles impact mitigating anger while driving (i.e., positive and negative). It was found that positive comments (e.g., "You are a real gentleman and good driver, and not chasing the car that abruptly cut off in.") are more effective in reducing self- reported anger compared with the negative style of comments (e.g., "The road may be congested; be careful and don't be angry." ). Similarly, Zhang, Ge [71] evaluated how relaxing music influences Chinese drivers' anger and performance, results suggested that relaxing music might improve drivers braking reaction time in simulated car-following tasks. In summary, most studies employed the educator to conduct interventions with a primary focus on cognitive aspects, e.g., Kazemeini, Ghanbari-e-Hashem-Abadi [17], Feng, Zhan [67]. In cases where an educator was not involved, assistance from vehicle interfaces was considered, e.g., feedback comments Li, Zhang [70]. In general, most studies involving educators were group-based with long duration, ranging from twenty days to seven weeks, and only one study labelled their intervention with the educator as the brief version (90 minutes). Meanwhile, self-reported approaches were primarily utilised by most researchers when examining the outcomes of interventions.

## Potential Challenges and Future Directions in the Field of Driving Anger Research

### Driving Anger in the era of Automated Driving

An interesting question would be proposed in advance to discuss further: Will driving anger be diminished in the era of automated driving? In essence, interacting with other road users is inevitable while driving, whereas provoking events and triggers are primary sources of driving anger during manual driving time [3]. For instance, anger-prone drivers (e.g., high trait driving anger) tend to evaluate anger-related situations in a hostile manner, which leads to angry responses, e.g., aggressive anger expressions [56, 72], but even though, drivers had lower levels of trait driving anger, specific aggressive and hostile situations could also elicit considerable anger [73]. This probably indicates that reducing the occurrence of anger-provoking situations on the road might be directly related to managing the driving anger phenomenon. It has been proposed that automated vehicles are safer than human drivers because they could reduce human errors, which is a crucial factor in crashes and dangerous driving [74, 75]. Assuming when we move toward an era where automated vehicles become prevalent, the road interactions might be changed significantly. For example, these vehicles could strictly adhere to traffic rules and avoid aggressive and risky actions such as cutting in line. In light of this, the likelihood of anger evoked by chaos and hostilities traffic environment might decrease. However, it is difficult to conclude whether the issue of driving anger has been significantly improved. Perhaps, some sources of driving anger could saliently emerge such as human-interface conflicts. A recent study revealed that drivers showed anger and frustration during automated driving in congested traffic situations, and drivers also demonstrated an increased number of take-over tendencies under time pressure [76]. This suggests that drivers might be annoyed, frustrated and angry if they find the driving style of an autonomous vehicle does not match their expectations or desires, e.g., stopping for no reason. Also, it has been found that drivers with higher trait driving anger and sensation seeking are associated with an angry driving style and more angry thoughts [77, 78]. Possibly, anger-prone and impulsive drivers retained similar maladaptive thoughts and preferred similar driving styles of automated vehicles, in other words, when their goals are interrupted, dangerous and impulsive driving could be "re-activated". In this sense, these groups of drivers remain to be focused in the context of autonomous driving. Meanwhile, the way of anger expression could be changed as well while operating an automated vehicle. For example, the displaced aggression might become salient, with drivers exhibiting aggression towards the interface or system if it malfunctions [79].

Consequently, to acquire a context-based understanding, there is a need to update measurements, e.g., assessing drivers' tendency to become angry while driving automated vehicles. Moreover, the occurrence of affective states might be concurrent and transient while driving with an automated vehicle. For example, a driver might initially experience frustration and anger when encountering a malfunctioning vehicle interface. However, the emotion could switch to anxiety and fear if the driver feels a loss of control or perceives a potential threat to driving safety. Thus, an integrated approach for evaluating emotional states is warranted [76], incorporating subjective assessment, real-time facial-emotional recognition, and physiological indicators can provide a deep and comprehensive understanding of varied emotions in the context of automated driving, especially when facing critical events [76, 80, 81]. In brief, updating appropriate measurements and integrating techniques for assessing driving anger in the context of autonomous driving is essential. This provides the


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foundation for further understanding of driving anger, and the key contextual-related aspects could be revealed, e.g., in what driving conditions, low and high anger drivers might be different in preferring the impulsive driving style of automated vehicles, and the "threshold" of low and high anger drivers initiated take over actions, which is beneficial to improve users' experience in target groups and preventing the activation of impulsive driving in an autonomous vehicle.

### The Dynamic of Driver's Cognitive Appraisal

Appraisal theories have become the leading theories of emotions [82]. In essence, Smith and Lazarus [83] indicated a cyclical process between, appraisal, coping, and reappraisal. In other words, an individual's appraisal is dynamic, which is related to the source of new information, emotions, and intensity of a person's coping ability and self-efficacy [84, 85]. For instance, drivers might be angry when confronting congested traffic and late for an important appointment, they perceive the situation as frustrating but believe it still being hopeful and manageable. However, as they continue driving, the seemingly "endless" situation and additional triggers, such as a never-ending congested traffic flow or a reckless driver abruptly cutting them off, could further influence their appraisal and subsequent actions. The magnitude of anger might escalate significantly in response to these stressors. This intensified anger could impair their judgment, leading to a heightened tendency to blame others and potentially increasing the likelihood of aggressive actions on the road. Meanwhile, changes in external situations could lead to decreased self-efficacy, possibly, anxiety may be experienced alongside anger [86]. This, in turn, may also increase attributing culpability. It is worth noting that, even though attributing culpability is the core relational theme of anger [87], once the stressor causality is linked with the conflict of personal interests and desires, the blame, regardless of its intensity, could not be easily avoided [88].

It has been suggested that negative emotions could influence convictions and coping potential is associated with emotional arousal [84]. Thus, in such circumstances, the impact of emotions and perceived coping capacity appears to be more important in shaping drivers' future appraisal when goals are hindered. Despite the importance of these dynamics, limited knowledge has been shown regarding the nature of the dynamic of drivers' cognitive appraisal in the context of driving anger. Stephens, Trawley [89] demonstrated that anger-provoked drivers adopted a heuristic style of natural driving towards potential hazards in a simulated driving environment, suggesting the role of "emotions as information" in an individual's appraisal [90]. Probably, designing simulated anger-provoking situations based on a multi-stage approach [91], could enable researchers to investigate the variation of drivers' cognitive appraisal while meeting different categories and different levels of arousal of anger-provoking situations, and how drivers' perceived coping capacity contributes to their subsequent appraisals and behavioural tendencies. In light of this, feedback loops among appraisal dimensions might be more explicit in the context of driving anger. Also, relying solely on Lazarus's appraisal theory might not sufficiently capture the dynamic nature of drivers' cognitive appraisal. Incorporating computational appraisal models with relevant maladaptive thoughts (e.g., driving anger thoughts) could provide a more accurate and comprehensive reflection for rapid and automatic dynamic process [82].

### Personalised Interventions for Driving Anger

An important concern while designing and conducting intervention research is the drop-out rate and the participants' willingness to attend, because of restricted time resources of participants and perceived insufficient monetary incentives [69, 92]. As presented above, most interventions were conducted in a long format, does it mean the long duration of the intervention is essential? According to a more recent review, short-term interventions for regulating risky driving appear to be more effective [93]. Therefore, refining relevant and key aspects of interventions and their length appears to be more important for targeted drivers' groups based on cultural and contextual considerations.

Nevertheless, it is unclear which form of intervention is more acceptable among drivers, e.g., technologies-based or educators-involved. However, both of which has their weakness, such as insufficient peer feedback in the former, and conformity effects in the latter. It could be reasonable and feasible to consider integrating these two formats in managing driving anger. For example, a proposed paradigm for integrated intervention in this review could start with a technology-based aspect, such as using real-time feedback to recognise and be aware of angry triggers in a controlled simulated environment. This session assists drivers to become aware of their emotional responses. To be noted, the "Co-design" could be valuable when designing vehicle-based tools for reducing anger, which refers to the equal collaboration and participation between stakeholders and designers [94]. This approach provides diverse inputs and an important foundation for developing strategies that are more likely to be accepted and effective [95]. Afterwards, the intervention could transition to an educator-based session. Drivers can discuss their experiences from the previous session in a group setting, receiving feedback from peers and educators, importantly, techniques of skilful coping and adaptive thinking could be delivered and practised with the support of the educator. This session may equip drivers with additional subjective emotional regulation skills and capacity. After all, equipping drivers with subjective emotional regulation skills and with the assistance of objective "support" could be regarded as a holistic strategy for enhancing driving safety and reducing driving anger. Furthermore, both subjective and


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objective measurements should be considered when evaluating the outcomes of the intervention to acquire comprehensive insights into its effectiveness. Finally, establishing the link between intervention findings and practical implications in practice should be taken into account. The broader impact could be achieved if research findings into policies could be testified, examined and implemented at a larger scale. Policymakers and researchers should consider how these potential policies could be integrated into existing traffic safety regulation frameworks, such as driving license training and safety campaign programmes.

## Conclusion

The exploration in the field of driving anger has been expanded after the advent of its measurements, e.g., DAS, DAX, etc. Recently, updated measurements for assessing constructs of driving anger have been developed, which might be more appropriate to the contemporary driving context. In addition, there appears to be an increasing interest in investing the impact of gender roles, the HEXACO personality traits and drivers' cognitive appraisal undertaken in anger provoking situations in driving anger studies. This provides more insights into driving anger through non-cognitive and cognitive perspectives. Moreover, some promising interventions have been recently conducted, suggesting their potential to regulate drivers' anger tendencies and aggressive anger expressions. However, with the rapid development of technology, future studies should consider understanding driving anger in a more context-based condition, including updating and assessing drivers' angry tendencies, anger expression and emotional responses in the context of automated driving. Furthermore, integrating theories and approaches might help assess the dynamics of drivers' cognitive appraisal while meeting different categories and arousals of anger-evoking situations, and designing combined interventions for comprehensive evaluations.

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