



Investigating the Relationship Between Mood and Driver Behaviors

Mediating Roles of Perceived Stress and Driving Anger

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Abstract: *Introduction:* Mood and emotion variously affect our behaviors. The present study examined the relationship between positive and negative affect and driver behaviors as well as the mediating role of perceived stress and driving anger. *Method:* A total of 369 drivers (age: $M = 35.52$, $SD = 10.61$) participated in the study by completing the Positive and Negative Affect Schedule, the Perceived Stress Scale, the Driver Anger Scale, the Driver Behaviour Questionnaire, and the Positive Driver Behaviour Scale. *Results:* Six serial mediation analyses revealed multiple mediations explaining violations the most and positive behaviors the least. Both positive and negative affects were associated with greater anger, leading to more violations. Moreover, positive affect was negative and negative affect was positively related to perceived stress, which in turn was related to increased violations. For positive behaviors, positive affect was associated with less perceived stress, which was associated with more positive behaviors. *Conclusion:* Moods and emotions reveal a tendency to behave in ways that can be dangerous to drivers and other road users. The study was particularly important because it was the first in the literature to examine positive and negative affect on driver behaviors, perceived stress, and driving anger.

Keywords: positive affect, negative affect, perceived stress, driving anger, driver behaviors

Introduction

Studies of driver behaviors in traffic provide crucial information for understanding, predicting, and modifying the behaviors of road users (adapted from Rothengatter, 2001, on traffic psychology). Driver behaviors in traffic have been a fundamental area of interest for road safety and traffic and transportation psychology researchers for many years, primarily because of the association of driver behaviors with negative outcomes such as crash involvement (e.g., de Winter & Dodou, 2010).

Driver behaviors and driver skills constitute the two essential elements of the driving task and are separately associated with crash involvement (Elander et al., 1993; de Winter & Dodou, 2010). Driver behaviors can be broadly categorized as aberrant driver behaviors (Reason et al., 1990) and positive driver behaviors (Özkan & Lajunen, 2005). According to the classification introduced by Reason et al. (1990), which is based on self-reported driver behaviors and has been studied in different countries

(de Winter & Dodou, 2010), aberrant driver behaviors are assessed in two main categories: errors and violations. Errors are defined as “the failure of planned actions to achieve their intended consequences” (p. 1315) and represent unintentional behaviors; violations are “deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system” (p. 1316), representing intentional behaviors. On the other hand, positive behaviors were conceptualized as behaviors that focus on the traffic environment (Özkan & Lajunen, 2005) and are multidimensional in nature: proactive and eco-friendly behaviors (Yılmaz Demirok, 2023). They promote smooth traffic flow and can be related to risk communication with or without prior attention (Yılmaz Demirok, 2023).

Models examining crash involvement and the predictive factors have identified distal and proximal factors (Lajunen, 1997; Sümer, 2003). Proximal factors encompass driving-specific factors (such as driver behaviors), while distal factors include more general characteristics such as personality traits.

Emotions emerged as one of the factors influencing driver behaviors (e.g., Hu et al., 2013; Scott-Parker, 2017; Steinhäuser et al., 2018). When considered in the context of the aforementioned distal and proximal factors, emotions can play a dual role: On the one hand, they can function as distal factors as emotions generally experienced by road users regardless of the context; on the other hand, emotions can be evaluated as driving-specific factors within the traffic environment (called contextual distal factors).

Various studies have addressed the similarities and differences between emotions, mood, and affect in different ways (e.g., Beedie et al., 2010; Ekkekakis, 2013; Manjunatha et al., 2009). Emotions refer to a situation experienced in a more limited timeframe, whereas mood spans a broader timeframe; affect is a more general concept that overlaps with various features of mood and emotion (Ekkekakis, 2013). This study examined mood (i.e., trait affect) and perceived stress as distal factors, while we considered driving anger a contextual distal factor regarding driver behaviors (proximal factors).

In road safety and driver behavior research, an individual's general emotional state, known as "mood" or "trait affect," is considered a key factor. Affect represents two emotional states: positive affect and negative affect. Positive emotions can be described as intense feelings of satisfaction, whereas negative emotions reflect a strong tendency toward dissatisfaction (Cropanzano et al., 2003). Positive emotions include mental states in which individuals experience emotions such as happiness, joy, and pleasure. Fredrickson (2001) proposed that positive emotions can potentially increase an individual's life satisfaction and overall well-being. These emotions can help individuals cope with stress, strengthen relationships, and promote personal development. In contrast, negative emotions detrimentally affect individuals, causing negative emotional experiences such as stress, anxiety, and anger.

Although affect has cognitive and behavioral consequences (Russell, 2003), the literature on the relationship between affect and driver behaviors is sparse, especially regarding studies on positive affect. For example, Albert et al. (2022) found that negative mood was associated with mind-wandering and risky behaviors. Various studies found a positive association between negative affect and risky driver behaviors (Hu et al., 2013) and aggressive behaviors (Kováčsová et al., 2016). Rhodes and Pivik (2011) found that positive affect positively predicted risky driving. In a driving simulator study, Zhang et al. (2020) showed that induced emotions, whether in anger or happiness, resulted in a shorter time to collision and an increased time to brake. Lawton et al. (2006) found that positive affect was positively related to violations such as speeding and

aggression, whereas negative affect was negatively related to speeding.

Stress emerged as another factor associated with driver behaviors in the literature. Throughout life, individuals may experience different stressors from different sources and at different times (Baum et al., 1990). Perceived stress is defined as the "degree to which individuals find their life unpredictable, uncontrollable, and overloading" (Lesage et al., 2012, p. 178). Perceived stress not only affects physical and mental health, it also influences everyday behaviors, including those related to driving. Stress has been associated with various outcomes, both as a distal factor, such as general perceived stress (Clapp et al., 2011; Ge et al., 2014; Öztürk et al., 2022) or work-related stress (e.g., Li et al., 2017; McLinton & Dollard, 2010; Öz et al., 2010), and as a contextual distal factor, like driving-focused stress (Kontogiannis, 2006; Qu et al., 2016). Drivers with a higher perceived stress level experienced more driving anger on the road (Öztürk et al., 2022). Similarly, as the stress level increases, drivers tend to exhibit more aberrant behavior (Ge et al., 2014; Delhomme & Gheorghiu, 2021; Kontogiannis, 2006), engage in more aggressive behaviors (Herrero-Fernández et al., 2024; Yasak et al., 2016), and experience more crashes (Qu et al., 2016; Kontogiannis, 2006; Taylor & Dorn, 2006).

Driving anger was defined as "more frequent and intense anger while operating a motor vehicle" by Deffenbacher et al. (1994, p. 84) and was addressed in various quantitative and qualitative studies regarding driving-related factors. These studies, in general, emphasized the relationship between high driving anger and higher frequencies of aberrant driver behaviors (Ergin et al., 2020; Ge et al., 2017; Li et al., 2021; Öztürk et al., 2021, 2024; Sullman et al., 2013, 2015; Villieux & Delhomme, 2010).

All these factors reflect that mood, perceived stress, and driving anger are individually associated with driver behavior (direct effects). However, after considering the relationship between the aforementioned distal and proximal factors (Lajunen, 1997; Sümer, 2003) and the link between the antecedent variables of driving anger and driver behaviors (Demir et al., 2016), we formulated the serial mediation model shown in Figure 1. In constructing the model, we followed the direction of the relationships between mood, emotion, and behavior (e.g., Bowen et al., 2020; Pizzo et al., 2024; Scott-Parker, 2017) and tested a relationship order from the most general (trait factor) to the most context-specific variable. This model suggests that general mood (measured with a trait affect measure) directly affects both perceived stress, driving anger, and driver behaviors. In addition, perceived stress and driving anger are thought to mediate the relationship between mood and driver behavior. Within this framework, this study examines the impact of mood on driver behaviors through perceived stress and driving anger.

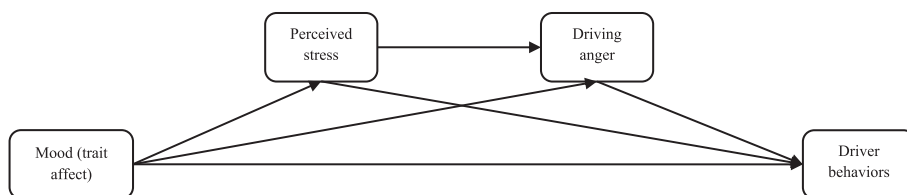


Figure 1. Serial mediation model of mood on driver behaviors through perceived stress and driving anger.

Table 1. Descriptive and correlations of study variables

	1	2	3	4	5	6	7	8	9	10	11
1. Age	1										
2. Gender	-.03	1									
3. Last year km	-.02	-.32***	1								
4. Lifetime km	.33***	-.38***	.50***	1							
5. Perceived stress	-.24***	.14**	-.07	-.20***	1						
6. Positive affect	-.05	-.11*	.10	.10	-.38***	1					
7. Negative affect	-.22***	.12*	.01	-.16**	.64***	.27***	1				
8. Driving anger	-.18**	.09	-.05	-.11*	.24***	.05	-.29***	1			
9. Errors	-.15**	.03	.01	-.03	.25***	-.07	.27***	.19***	1		
10. Violations	-.27***	-.14**	.10	.03	.32***	-.01	.34***	.34***	.51***	1	
11. Positive behavior	.09	.01	.11*	.09	-.15**	.12*	-.13*	.06	-.25***	-.09	1
<i>M</i>	35.53	–	13383.42	131485.80	2.79	4.77	3.09	3.48	1.55	2.09	4.99
<i>SD</i>	10.61	–	15616.53	145862.85	0.56	0.81	0.89	0.70	0.55	0.76	1.15

Notes: Variables: LYKM: Last year kilometers, LTKM: Lifetime kilometers, PS: Perceived stress, DAS: Gender was dummy coded as 1: Male, 2: Female, * $p < .05$, ** $p < .01$, *** $p < .001$.

Method

Participants

A total of 369 drivers between 18 and 68 years ($M = 35.52$, $SD = 10.61$) with a valid full vehicle (type B) driving license participated in the study, 247 male and 122 female drivers. Table 1 present the characteristics of the sample, together with correlations.

Materials

The survey battery included the Positive and Negative Affect Schedule, Perceived Stress Scale, Driver Anger Scale, Driver Behaviour Questionnaire, Positive Driver Behaviour Scale, and a demographic information form.

Positive and Negative Affect Schedule-PANAS

Watson et al. (1988) developed the PANAS scale to measure mood (Ekkekakis, 2013) and the affective states and traits of individuals (Watson et al., 1988). The scale assumes that the emotional structure consists of two independent basic dimensions. It defines positive affect as active pleasure and enjoyment of life. It defines negative affect as the activation of distressing emotions such as guilt, fear,

and anger. The inactivity of the emotions indicates that the associated factor is low. Gençöz (2000) prepared the Turkish adaptation of the scale. The scale consists of a total of 20 items, and each item contains an adjective indicating an emotional state. Individuals rate how often they experience each emotional state on a 7-point Likert-type scale from 1 (*Never*) to 7 (*Always*). The Cronbach's alpha reliabilities of positive affect and negative affect were .82 and .86, respectively.

Perceived Stress Scale (PSS)

Cohen et al. (1983) developed the PSS to measure how much stress participants have experienced in the past month. Eskin et al. (2013) carried out the Turkish adaptation of the scale. The scale consists of 14 items in total and is evaluated as a 5-point Likert from 0 (*Never*) to 4 (*Very often*). The current study calculated a total perceived stress score, with higher scores indicating a higher stress level. The Cronbach's alpha reliability of the total scale was .86.

Driver Anger Scale (DAS)

Deffenbacher et al. (1994) developed the DAS to measure how angry drivers become in some traffic situations. The original scale has a 6-factor structure, measuring driving anger in the dimensions of disrespect/rudeness,

presence of traffic police, aggressive/hostile actions, rule violation, slow driving, and traffic environment obstacles. The current study used the 14-item single-factor short version, rated on a 5-point Likert scale from 1 (*None at all*) to 5 (*Very much*). Yasak and Esiyok (2009) made the Turkish adaptation of the scale. As the total score increases, the intensity of anger experienced by the drivers in traffic increases. The Cronbach's alpha reliability of the scale was .88.

Driver Behavior Questionnaire (DBQ) – Positive Driver Behavior Scale (PDBS)

Reason et al. (1990) developed the DBQ, which measures aberrant driver behaviors, and included two main factors of violations and errors. Özkan and Lajunen (2005) developed the PDBS and used a single-dimension scale with 14 items. The present study used the 19-item short version of the behavior measure, combining the DBQ and the PDBS (Ersan et al., 2020). The scale included errors (8 items), violations (7 items), and positive driver behaviors (4 items) dimensions. The scale is rated on a 6-point Likert-type scale from 1 (*Never*) to 6 (*Always*). The Cronbach's alpha reliabilities of the dimensions were .82 for errors, .77 for violations, and .80 for positive behaviors.

Demographic Information Form

Participants answered questions about their age, gender, kilometers traveled in the last year, and kilometers traveled in their lifetime.

Procedure

Following approval by the Middle East Technical University Human Research Ethics Committee (Protocol No: 371-ODTU-2020), we distributed the study via Qualtrics, an internet-based data collection platform. We anonymously collected the data using snowball and convenience sampling methods and assured participant confidentiality. The survey took approximately 20 minutes to complete.

Analyses

We recorded a total of 616 data points. We followed suggestions from recent studies (e.g., Chikodili et al., 2020; Curran et al., 2016; Mirzaei et al., 2022) in treating missing data and outliers. First, we excluded 164 participants because they did not properly complete the questionnaire (did not reach the end of the questionnaire; their data were recorded as a partial response). Of the remaining participants, we excluded 58 because of unrealistically fast response times (completed the entire questionnaire in less than 5 minutes;

see Curran, 2016, for a discussion of careless/low-quality responses). We excluded participants who completed less than 90% of each scale from the dataset ($n = 19$). We also excluded participants with extreme values for lifetime kilometers and age (extreme value defined as a z -score of 3.0) ($n = 6$). We excluded extreme cases that could affect the quality of responses and the driving experience and exposure.

We controlled the statistical effects of the demographic variables after excluding these cases. The first part of the results presents descriptive statistics and bivariate correlations. Following the correlations, we conducted six mediation analyses to examine the role of perceived stress and driving anger in the relationship between positive/negative affect and driving behaviors (errors, violations, and positive behaviors). We conducted the analyses using the Statistical Package for the Social Sciences (SPSS) v.26 program and the PROCESS macro (Hayes, 2022) model six. We entered age, gender, and kilometers in the last year into the model as control variables in the analyses.

Results

Descriptive and Correlations

Bivariate correlation coefficients showed that age negatively correlated with perceived stress, negative affect, driving anger, errors, and violations. Perceived stress positively correlated with negative affect, driving anger, errors, and violations and negatively correlated with positive affect and positive behaviors. Positive affect positively correlated with negative affect and positive driver behaviors. Negative affect positively correlated with errors and violations and negatively with driving anger and positive behaviors. Driving anger positively correlated with errors and violations. Finally, errors positively correlated with violations and negatively with positive behaviors.

Mediation Analyses

In the final step, we examined the indirect effect of positive/negative affect through perceived stress and driving anger on driver behaviors with six serial mediation analyses (see Analyses section for further details). Table 2 presents the explained variances (R^2).

As Figure 2 shows, the indirect effects of positive affect on errors through perceived stress (indirect effect = $-.05$, $SE = .02$, $CI = -.09, -.02$), driving anger (indirect effect = $.02$, $SE = .01$, $CI = .00, .03$), and perceived stress-driving anger (indirect effect = $-.01$, $SE = .01$, $CI = -.03, -.00$) were significant. Additionally, only the indirect effect of negative

Table 2. Explained variances across positive and negative affect

	Positive affect		Negative affect	
	Total effect R^2	Final model R^2	Total effect R^2	Final model R^2
Errors	.03	.09	.03	.08
Violations	.05	.10	.04	.19
Positive behaviors	.03	.04	.02	.04

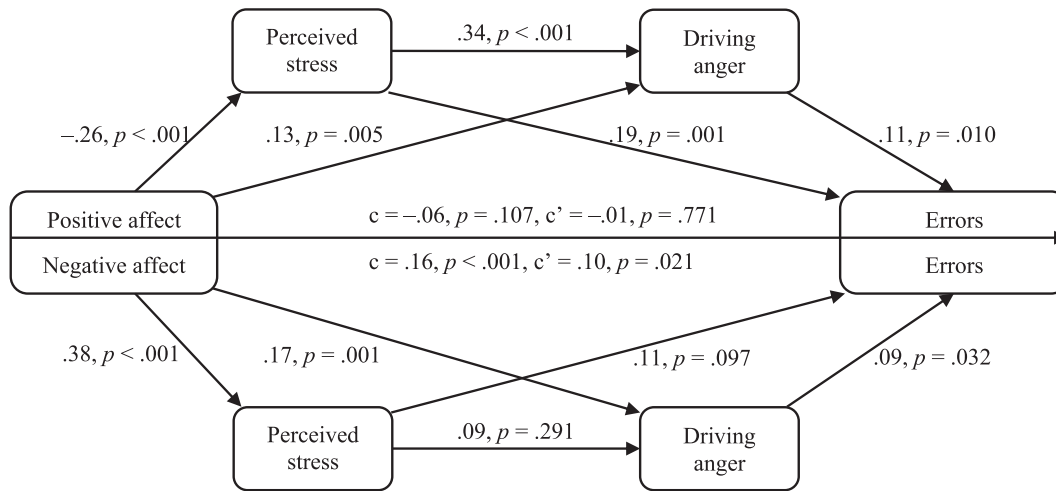


Figure 2. Effect of positive/negative affect through perceived stress and driving anger on errors.

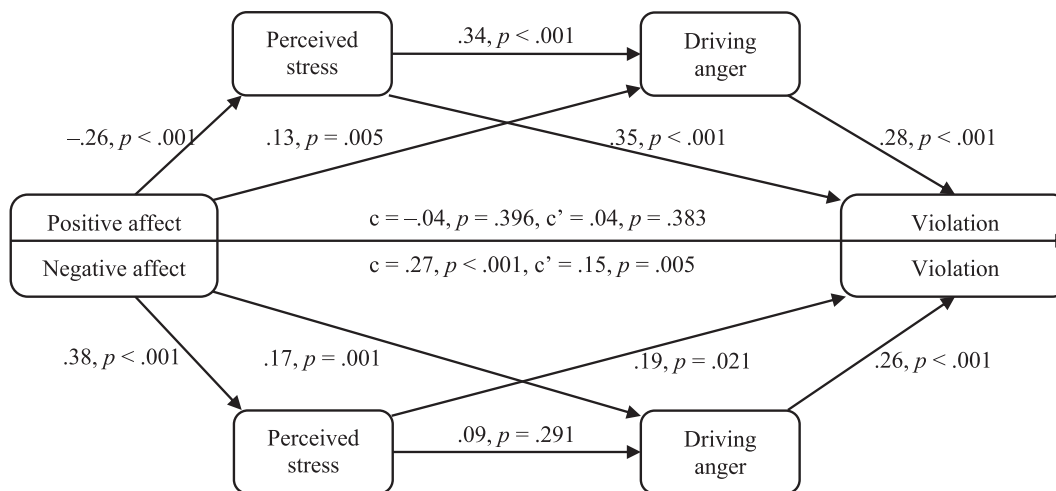


Figure 3. Effect of positive/negative affect through perceived stress and driving anger on violation.

affect on errors through driving anger was significant (indirect effect = .02, $SE = .01$, $CI = .00, .06$).

As Figure 3 shows, the indirect effects of positive affect on violations through perceived stress (indirect effect = $-.09$, $SE = .03$, $CI = -.15, -.05$), driving anger (indirect effect = $.04$, $SE = .02$, $CI = .01, .07$), and perceived stress-driving anger (indirect effect = $-.03$, $SE = .01$, $CI = -.04, -.01$) were

significant. Additionally, the indirect effects of negative affect on violations through perceived stress (indirect effect = $.09$, $SE = .04$, $CI = .00, .17$) and driving anger (indirect effect = $.05$, $SE = .02$, $CI = .02, .09$) were significant.

As Figure 4 shows, the indirect effect of positive affect on positive behaviors through perceived stress was significant (indirect effect = $.05$, $SE = .02$, $CI = .01, .09$).

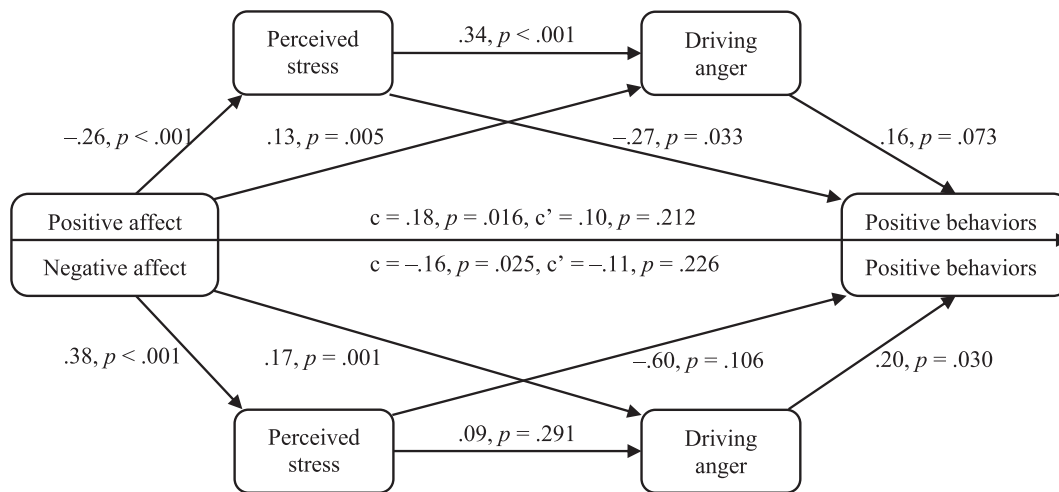


Figure 4. Effect of positive/negative affect through perceived stress and driving anger on positive behaviors.

Discussion

The present study investigated the effects of perceived stress and driving anger on the association between emotional experiences and driver behaviors. We did this by administering an online survey battery that included a demographic information form, the Perceived Stress Scale (PSS), the Positive-Negative Emotion Scale (PANAS), the Driver Behavior Scale (DBQ), and the Driver Anger Scale (DAS).

Our correlation findings are consistent with the previous research. As age increased, we observed decreases in perceived stress, negative affect (e.g., Shallcross et al., 2013), driving anger (e.g., Sullman et al., 2015), and aberrant behavior (e.g., de Winter and Dodou, 2010). Furthermore, males reported higher levels of positive affect (Rhodes & Pivik, 2011) and violations (e.g., de Winter & Dodou, 2010), whereas females reported higher levels of perceived stress (Graves et al., 2021) and negative affect (e.g., Thomsen et al., 2005).

The mediation models examining the relationship between the positive and negative affect and perceived stress and driving anger reveal that the results confirm the inverse relationship between happiness and perceived stress found by Schiffrin and Nelson (2008). Participants with higher positive affect reported lower perceived stress. Moreover, both positive and negative affect showed a positive relationship with driving anger. These findings support the previous association between positive affect and risky driving (Rhodes & Pivik, 2011) through the positive relationship with driving anger. Furthermore, the positive relationship between negative affect and trait anger found by Ng et al. (2019) continues to be with driving anger.

For the mediation models between positive affect and driving behavior, stronger positive affect was associated

with lower perceived stress, which was later related to more positive behavior and fewer errors and violations. Furthermore, positive affect was positively associated with aberrant driving behavior (i.e., errors and violations) through increased driving anger. Finally, the serial mediation models showed that higher levels of positive affect were associated with reduced perceived stress, which was subsequently associated with reduced driving anger, leading to fewer driving errors and violations. Although the relationship between positive affect and risky driving (e.g., Lawton et al., 2006; Rhodes & Pivik, 2011) appears to continue here with driving anger, positive affect may also play a protective role for perceived stress. The relationship between aberrant driving behavior can be explained by the same motivational direction of positive affect and anger suggested by Harmon-Jones et al. (2011). The relationship between positive affect and perceived stress is similar to the valence of emotions mentioned in the related study, while the relationship between positive affect and driving anger occurs through the motivational component of emotion.

Furthermore, we found positive driver behavior to have the weakest relationships among the variables. We think this is mainly because positive behaviors are not commonly seen in traffic and are considered secondary behaviors. The display of these behaviors by individuals with high positive affect may also be related to the intentional nature of these behaviors. The positive relationship between positive affect and prosocial behavior in life in general (Snippe et al., 2017) may be reflected in this way in the context of driving. In other words, the results suggest that drivers with high positive affect in the driving context may perceive less stress and engage in positive behavior when given the opportunity in traffic. Less perceived stress may emotionally and cognitively prepare drivers to engage in additional positive behavior based on positive affect.

For negative affect and driver behaviors, we found high negative affect to be associated with more errors and violations through increased driving anger and with more violations through increased perceived stress. Although the positive association between negative affect and violations is not surprising, given the relationship between negative affect and anger (Ng et al., 2011) and aberrant behaviors and perceived stress (Ge et al., 2014; Delhomme & Gheorghiu, 2021; Kontogiannis, 2006) and driving anger (Demir et al., 2016), the positive association with errors suggests that drivers may unintentionally engage in a range of unsafe behaviors as a result of negative affect. While naturalistic driving data does not support naturalistic driving data (Precht et al., 2017), one of the determining factors here may be driver skills. In other words, driver skills may moderate driving anger and errors. The activation of strong emotions with negative affect during driving and the increase in driving anger may lead to the experience of errors by drivers who do not have sufficient driving skills to cope with a particular situation.

Limitations, Implications, and Suggestions for Future Research

The current study has several limitations because of the research method and sample characteristics. First, using self-reported data requires considering the possible effects of memory problems, social desirability, and self-report biases. Second, the study sample is not representative. As stated earlier, the relationship between the variables is based on previous literature focusing on distal and proximal factors (Lajunen, 1997; Sümer, 2003) and the relationships between mood, emotion, and behavior (e.g., Bowen et al., 2020; Pizzo et al., 2024; Scott-Parker, 2017). However, the results are correlation-based retrospective findings, making it difficult to show a causal relationship. This could create a problem concerning the generalisability of the results.

In addition, the low variance explained by the models and significant but weak correlations suggest that the current model is robust but needs improvement to better explain driver behavior. Future studies that examine the relationship more systematically and with other variables may make further contributions. In addition to mood (trait affect as elaborated in the current study), examining shorter-term emotions (see Beedi et al., 2010 for further discussion on mood and emotion difference) triggered by situations/behaviors may help us better understand the nature of the interactions. For example, certain interactions of drivers with other road users and situations may trigger strong emotions (e.g., driving anger; Stephens et al., 2019). For this reason, future studies could employ experimental methods such as driving simulators (e.g., Emo et al., 2016; Zhang

et al., 2020) and various physiological measures and thermography (e.g., Zhang et al., 2019) to collect more objective data and establish causal findings.

We used driving anger as a single-factor construct, but the literature indicated that different situations lead to varying levels of anger experienced by drivers (e.g., Stephens et al., 2019; Yasak & Esiyok, 2009). For example, in a simulator study, driving at a slow pace in traffic was observed to induce both anger and stress (Emo et al., 2016). In this study, while there was a negative relationship between positive affect and perceived stress and a positive relationship between perceived stress and driving anger, the positive relationship between driving anger and positive affect suggests that the association examined may vary depending on situational factors.

According to the results, while positive/negative affect, perceived stress, and driving anger were related to driver behaviors, the strongest associations were observed for violations. In particular, positive relationships were found for driving anger, irrespective of positive or negative affect. Although the explained variances were not high, it can still be suggested that, whether general or driving-specific, emotions are crucial to driver behavior, especially for violations, and cannot be neglected. Furthermore, while the findings highlight the separate roles of positive and negative affect, the results have important implications for intervention programs that focus on topics such as driving anger (e.g., Deffenbacher, 2016) and affect (e.g., Schumer et al., 2018).

Conclusion

The current study examined the relationship between mood and driver behavior through perceived stress and driving anger. The results reveal that both positive and negative affect contributed to an increase in driving anger, leading to an escalation of errors and violations. In addition, higher positive affect was associated with a decrease in perceived stress, followed by a decrease in aberrant driving behavior and an increase in positive driving behavior. Finally, the serial mediation effect was observed only for positive affect and aberrant driving, indicating that higher levels of positive affect were associated with reduced perceived stress, which was subsequently associated with reduced driving anger, leading to fewer aberrant behaviors.

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History

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Conflict of Interest

The authors declare no conflict of interest.




Authorship

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Data are available upon request from the corresponding author (IO).

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