The effect of stress and personality on dangerous driving behavior among Chinese drivers

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Abstract

The relationship between stress and road safety has been studied for many years, but the effect of global stress and its joint effect with personality on driving behavior have received little attention in previous studies. This study aimed to elucidate the impact of global stress and various personality traits on driving behavior. 242 drivers completed the Perceived Stress Scale-10 (PSS-10), the Dula Dangerous Driving Index (DDDI), and several personality trait scales related to anger, sensation seeking, and altruism. The results showed that perceived stress and sensation seeking were significantly correlated with the four subcategories of dangerous driving behavior, namely, negative cognitive/emotional driving (NCED), aggressive driving (AD), risky driving (RD), and drunk driving (DD). Moreover, anger was positively correlated with negative cognitive/emotional driving, aggressive driving, and risky driving, and altruism was negatively correlated with aggressive driving and drunk driving. Hierarchical multiple regressions were applied to analyze the mediating effect of personality traits, and the results showed that anger mediated the relationship between stress and dangerous driving behavior and that this mediating role was especially strong for negative cognitive/emotional driving and aggressive driving. Collectively, the results showed that stress is an important factor that can affect people's driving behavior but that personality traits mediate the effect of stress on driving behavior. The findings from this study regarding the relationship among stress, anger, and dangerous driving behavior could be applied in the development of intervention programs for stress and anger management in order to improve drivers' ability to manage emotional thoughts and adjust their behavior on the road.

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1. Introduction

Stress is a modern phenomenon that affects almost everyone. Researchers commonly conceptualize stress as the body's response to any demand that exceeds individuals' adaptive capacity (Selye, 1936; see Kopp et al., 2010 for a review). Stress has been shown to have an obvious impact on attention (Ellenbogen et al., 2002), anxiety (Caplan, 1994; Graeff et al., 1996), working memory (Ashcraft and Kirk, 2001), and perceptual-motor performance (van Galen and van Huygevoort, 2000). Moreover, evidence from cognitive neuroscience has revealed that stress hormones affect prefrontal brain regions and dopaminergic pathways (Moghaddam and Jackson, 2004; Wang et al., 2005). As a daily activity, driving behavior is influenced by various stressors (Gulian et al., 1989; Rowden et al., 2011).

Previous studies have explored the relationship between driving-related stress and road safety. Driving-related stress mainly arises from personal and environmental factors that make drivers feel stressed when they are driving (Rowden et al., 2011). Driver stress is an important factor in research on the relationship between driving-related stress and driving behavior. Driver stress mainly occurs when an individual perceives his or her driving ability to be insufficient to manage the demands and dangers of driving, and it may induce a dislike of driving and hazard monitoring (Gulian et al., 1989; Matthews, 2002). Dislike of driving encompasses a driver's feelings of anxiety, tension, frustration, and joylessness and lack of confidence, especially in complicated driving situations (Matthews et al., 1998). Matthews et al. (1998) found that a dislike of driving is associated with diminished control skills in simulated driving tasks. Other studies have revealed that high levels of driver stress are associated with increased self-reported mistakes and violations during driving (Kontogiannis, 2006; Westerman and Haigney, 2000). Another factor in driving-related stress is the driving environment, which generates stressors related to time pressure, congestion, and road conditions (Hennessy...
In addition to stressors related to driving and the driving environment, other stressors that are extraneous to the driving situation, such as life events and daily frustrations, may influence driving behavior and the occurrence of traffic violations. Lagarde et al. (2004) found that drivers who are going through separation or divorce are more likely to be involved in serious traffic accidents. High job stress has also been shown to be an effective predictor of future vehicle accidents (Norris et al., 2000). A study of military personnel found that participants who had recently returned from combat zones reported significantly higher scores on risk and aggressive driving measures than other drivers did, and the results indicated that stress could be a significant predictor of their traffic violations (Mitra-Sarkar and Andreas, 2009). Rowden et al. (2011) provided further evidence of the impact of stress from various sources on driving behavior and road safety. They found that daily hassles that are extraneous to the driving environment could affect driving lapses and violations. However, previous studies have generally focused on one specific event only. In fact, numerous life events, such as taking an important exam or experiencing certain diseases, can affect individuals’ stress levels, but exhaustively studying all of these life events is impossible. Moreover, stress is common in modern society; it can arise from everyday stressors that are ignored or poorly managed. Global stress refers to subjective, perceived psychological stress arising, for instance, from an individual’s feelings that his/her life has become unpredictable, out of control, or overwhelming; however, the stressors causing such stress are general in nature rather than specific to a particular event or experience (Cohen et al., 1983; Cohen and Janicki-Deverts, 2012). Further, to our knowledge, no study has directly explored the influence of global stress on driving safety.

Individual differences such as age, gender, driving experience, and personality traits are important factors that may interact with stress in affecting driving safety (Mather et al., 2009; McLinton and Dollard, 2010; Öz et al., 2010; Simon and Corbett, 1996). Among these factors, personality traits have attracted the most attention in the literature. In particular, previous researchers have investigated the joint effect of personality and stress on driving safety. Hogan and Dollard (2007) discussed the relationship between work stress and driving anger and the mediating effect of trait anger on this relationship. McLinton and Dollard (2010) also showed that trait anger fully mediated the relationship between work stress and road anger. Previous studies have also explored the effect of personality on driving performance under stress. For instance, Morton and White (2013) investigated the effect of a fear-based personality trait on drivers’ performance under psychological stress. The authors used reinforcement sensitivity theory (RST) to show that stress may lead to riskier driving behavior in people with fearful personality types. Nevertheless, these studies have some limitations. First, each study focused on only one specific stressor. Whether these effects can be extended to other stressors remains unknown; thus, exploring individuals’ perceived global stress levels, which are not based on any specific life event, could expand existing research. Second, the mediating effect of only one personality trait was explored in each study. Previous studies have found that other personality traits, such as sensation seeking and altruism, are significantly correlated with driving behavior (Dahlen et al., 2005; Machin and Sankey, 2008). These traits could interact with stress to affect driving behavior. Third, previous studies explored only one aspect of driving behavior, e.g., driving anger (Hogan and Dollard, 2007; McLinton and Dollard, 2010) or performance in simulated driving (Morton and White, 2013). Aggressive and risky driving behavior could be jointly influenced by stress and personality. These issues thus require systematic and meticulous investigation.

Specific types of stress and road safety have received considerable attention individually in the literature, but the effect of global stress and its joint effect with personality on driving behavior have received little attention in previous studies. As a developing country with a short history of automobile usage, China presents a unique social and traffic environment (Zhang et al., 2010). Thus, drivers’ behavior in such an environment needs to be investigated in order to reduce the potential influence of stress and related personality traits on dangerous driving behavior among Chinese drivers. The current study had two main goals. First, we aimed to explore the influence of drivers’ global stress on their driving behavior. To date, no studies have explored the link between driving safety and stress in China. We used the Perceived Stress Scale (PSS-10) to measure the global stress that drivers perceive in their everyday life. This scale does not focus on any specific type or source of stress but captures the global stress derived from ongoing life circumstances and from expectations concerning future events (Cohen et al., 1983; Cohen and Janicki-Deverts, 2012). Second, we aimed to expand research on the combined effect of personality and stress on driving safety. Anger, sensation seeking, altruism, and normlessness are effective predictors of risky driving and traffic violations in China (Yang et al., 2013). Thus, these personality traits were examined in this study. The Dula Dangerous Driving Index (DDDI, Dula and Ballard, 2003; Qu et al., 2014) was used as the principle measure for unsafe driving behavior. This index includes four subcategories: negative cognitive/emotional driving (NCED), aggressive driving (AD), risky driving (RD), and drunk driving (DD). NCED refers to driving with negative feelings, such as anger or frustration; AD is defined as any behavior in which a driver intends to physically or psychologically harm others; RD refers to driving with potentially negative outcomes but not with the intention to cause harm to others, such as speeding; and DD is self-evident—driving after drinking (Dula and Ballard, 2003; Qu et al., 2014; Willemsen et al., 2008). This scale allowed us to analyze the effect of stress and personality on each of the four subcategories of driving behavior. Moreover, self-reported traffic violations were also measured, including the number of accidents over the previous three years and the number of penalty points and fines during the past year. The penalty point system is a measure that is used to punish drivers who have violated a traffic law. For example, a driver receives six penalty points for driving through a red light. If a driver receives 12 penalty points in one year, his or her driver’s license is suspended.

2. Methods

2.1. Participants

In total, 309 drivers voluntarily participated in this study; the participants were recruited from residential living communities, train stations, the Commodity Wholesale Market Center, and the graduate school of the Institute of Psychology, Chinese Academy of Sciences. Each participant received a gift or 20 RMB as a reward for completing the survey. The final data set comprised 242 valid responses because some of the surveys were not filled out completely or seriously. The final sample included 119 males (49.27%) and 123 females (50.8%). The average age of the final sample was 23.75 years (SD = 4.68 years, ranging from 18 to 61). A total of 239 (98.8%) participants reported the number of years they had been driving, which averaged 6.38 ± 4.68 years (ranging from 0.5 to 25). A total of 236 (97.5%) participants reported the total number of traffic accidents that they were involved in while driving in the past 3 years; the average number was 1.99 ± 2.18 (ranging from 0 to 10). Further, 228 participants (94.2%) reported the total penalty points for traffic citations that they had received in the last year; the mean value was 1.89 ± 2.84 points (ranging from 0 to 12).
2.2. Instruments

2.2.1. Dula Dangerous Driving Index (DDDI)

The DDDI was created by Dula and Ballard (2003) to measure dangerous driving behavior. Drivers evaluate features of their everyday driving on a Likert scale with 1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = always. The Chinese version of the DDDI has been shown to exhibit excellent reliability and validity (Qu et al., 2014). The internal consistency, indexed by Cronbach’s alpha coefficient (Clark and Watson, 1995), was as follows for the four subcategories: RD (10 items, $\alpha = 0.78$); NCED (9 items, $\alpha = 0.80$); AD (7 items, $\alpha = 0.78$); and DD (2 items, $\alpha = 0.63$). This scale showed excellent internal consistency in the total DDDI score (all 28 items, $\alpha = 0.90$).

2.2.2. Perceived Stress Scale-10 (PSS-10)

The PSS-10 (Cohen et al., 1983) is one of the most widely used tools for evaluating the level of stress experienced by a subject in the last month. Participants evaluate the frequency of uncontrollable, unpredictable, and overwhelming events in their life during the previous month. None of the items focus on specific events or experiences. The Chinese version of the PSS-10 used in this study was translated by Wang et al. (2011), and it has been shown to have sufficient internal consistency ($\alpha = 0.86$). The PSS score is derived by summing the scores for the 10 items, which are scored on a Likert scale with 0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, and 4 = very often.

2.2.3. Personality scales

The personality scales consist of 4 traits that have been shown to be related to driving safety in China (Yang et al., 2013). These 4 traits are Anger (10 items, $\alpha = 0.84$), Sensation seeking (10 items, $\alpha = 0.73$), Altruism (10 items, $\alpha = 0.77$), and Normlessness (4 items, $\alpha = 0.63$). The original version of the first three traits came from the International Personality Item Pool (IPIP, http://ipp.org, Goldberg et al., 2006). Anger is a trait referring to an individual’s perception of a wide range of situations as annoying or frustrating. Sensation seeking refers to an individual’s desire for and engagement in varied, novel, and arousing experiences. Altruism is a trait referring to an individual’s propensity to be cooperative, kind-hearted, and actively concerned about others. Normlessness is evaluated using Kohn and Schooler’s (1983) scale, which measures the belief that socially unacceptable behaviors are required to achieve certain goals. Each trait was scored by averaging the scores for the items, which were answered on a 5-point Likert scale ranging from 1 = “strongly disagree” to 5 = “strongly disagree”.

2.3. Procedure

Questionnaire packets containing each of the surveys described above were distributed to the participants, who were told that their responses would be confidential and used only for scientific research. This study was approved by the Institutional Review Board of the Institute of Psychology, Chinese Academy of Sciences.

3. Results

3.1. Descriptive statistics

Table 1 provides descriptive statistics for all the measures in each scale. The reliability coefficients were acceptable ($\alpha > 0.60$) for all the scales except for normlessness, so that scale was not included in the analysis. In the questionnaires, 71.5% of the drivers reported being involved in one or more traffic accidents (including a crash) in the last three years, and 39.7% of the drivers reported receiving a penalty for violating traffic rules during the last year.

3.2. Correlation analysis

A two-tailed Pearson correlation analysis was performed to examine the relationships among perceived stress, personality traits, and dangerous driving behavior while controlling for age, gender and number of years driving. Perceived stress was significantly and positively correlated with all the subcategories of the DDDI, namely, RD, AD, NCED, and DD, as well as the total DDDI score. There were various trends and directions for the correlations between each personality trait and the DDDI. Anger was positively associated with all the subcategories of the DDDI and the total DDDI score, except no significant relationship was found between anger and DD. Sensation seeking was positively associated with all the subcategories of the DDDI and the total DDDI score. Altruism was significantly negatively correlated with AD and DD only. The PSS score was positively correlated with anger and negatively correlated with altruism, but no significant relationship was found between perceived stress and sensation seeking. Table 2 presents the details of the analysis. The correlations between perceived stress and the number of traffic accidents in the past 3 years, the penalty score in the last year, and penalty points in the last year were not significant; these results are thus not included in Table 2.

3.3. Hierarchical multiple regression analysis

3.3.1. Direct effects

To test the direct effects of stress and each personality trait, hierarchical multiple regression analyses were conducted by regressing each predictor variable on the four subcategories of the DDDI and the total DDDI score separately while controlling gender, age, and number of years driving in the first step. The results revealed that perceived stress was a significant predictor of NCED ($\beta = 0.168, p < 0.01$), AD ($\beta = 0.204, p < 0.01$), RD ($\beta = 0.142, p < 0.05$), DD ($\beta = 0.199, p < 0.01$), and the total DDDI score ($\beta = 0.204, p < 0.01$). Different trends and directional effects were revealed for the various personality traits on the DDDI. Anger was a significant predictor of NCED ($\beta = 0.281, p < 0.01$), AD ($\beta = 0.235, p < 0.01$), RD ($\beta = 0.145, p < 0.05$), and the total DDDI score ($\beta = 0.249, p < 0.01$) but was not a significant predictor of DD. Sensation seeking was a significant predictor of all sub-categories of the DDDI and the total DDDI score (all $p < 0.05$). Altruism was a significant predictor of AD ($\beta = -0.178, p < 0.01$) and DD ($\beta = -0.167, p < 0.01$). Table 3 presents the results of the regression analyses.

Table 1

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Descriptive statistics for all variables.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of items</td>
</tr>
<tr>
<td>PSS-10</td>
<td>10</td>
</tr>
<tr>
<td>Personality</td>
<td></td>
</tr>
<tr>
<td>Normlessness</td>
<td>4</td>
</tr>
<tr>
<td>Anger</td>
<td>10</td>
</tr>
<tr>
<td>Sensation seeking</td>
<td>10</td>
</tr>
<tr>
<td>Altruism</td>
<td>10</td>
</tr>
<tr>
<td>DDDI</td>
<td>28</td>
</tr>
<tr>
<td>NCED 9</td>
<td>0.79</td>
</tr>
<tr>
<td>AD 7</td>
<td>0.77</td>
</tr>
<tr>
<td>DD 2</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Note: PSS = Perceived Stress Scale; NCED = negative cognitive/emotional driving; AD = aggressive driving; RD = risky driving; DD = drunk driving; DDDI = the Dula Dangerous Driving Index.
Table 2
Correlations among perceived stress, personality traits, and dangerous driving behavior.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PSS</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2 Anger</td>
<td>0.44**</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3 Sensation seeking</td>
<td>0.017</td>
<td>0.026</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4 Altruism</td>
<td>–0.355**</td>
<td>–0.451**</td>
<td>0.084</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5 NCED</td>
<td>0.169**</td>
<td>0.277**</td>
<td>0.231**</td>
<td>–0.086</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>6 AD</td>
<td>0.206**</td>
<td>0.232**</td>
<td>0.242**</td>
<td>–0.178**</td>
<td>0.640**</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7 RD</td>
<td>0.144</td>
<td>0.144</td>
<td>0.408**</td>
<td>–0.057</td>
<td>0.642**</td>
<td>0.597**</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>8 DD</td>
<td>0.198**</td>
<td>0.069</td>
<td>0.145</td>
<td>–0.165</td>
<td>0.254**</td>
<td>0.306</td>
<td>0.353**</td>
<td>–</td>
</tr>
<tr>
<td>9 Total DDDI</td>
<td>0.206**</td>
<td>0.246**</td>
<td>0.346**</td>
<td>–0.126</td>
<td>0.880**</td>
<td>0.826**</td>
<td>0.880**</td>
<td>0.429**</td>
</tr>
</tbody>
</table>

Note: All correlations were adjusted for age, gender, and number of years driving. All tests are two-tailed. *p < 0.05. **p < 0.01.

3.3.2. Mediating effects

To test the potential mediating effect of personality traits on the relationship between perceived stress and dangerous driving behavior (as measured by the four subcategories of the DDDI and the total DDDI score), we followed the four steps outlined by Baron and Kenny (1986): Step 1, test the effect of perceived stress on dangerous driving behavior to show that an effect exists that may be mediated; Step 2, test the relationships between perceived stress and personality traits in separate regressions to show that perceived stress is correlated with the mediators; Step 3, test the effect of personality traits on dangerous driving while controlling for demographic variables and perceived stress to show that the mediators (personality traits) influence dangerous driving behavior; and Step 4, test the effect of perceived stress on dangerous driving behavior while controlling for personality traits—if the effect disappears, the relationship between perceived stress and dangerous driving behavior is completely mediated by the examined personality trait. Finally, we performed a Sobel test to examine whether the mediating effect was significant. The mediating effect of sensation seeking was not analyzed because there was no significant relationship between perceived stress and sensation seeking.

We analyzed the mediating effects of anger and altruism separately, but no significant mediating effect for altruism was found. Therefore, we report the results for anger only.

The main results of the mediating effect analysis are shown in Table 4. Perceived stress significantly predicted each of the subcategories of the DDDI (Model 1), satisfying step 1. Then, in the regression of perceived stress on anger, perceived stress was found to be a significant predictor of anger after controlling for demographic variables (β = 0.432, p < 0.01), satisfying step 2. In step 3, dangerous driving behavior was regressed on anger with perceived stress in the model (Model 2). The relationships between anger and NCED, AD, and the total DDDI score were significant, satisfying step 3. Moreover, the effect of perceived stress on NCED, AD, and the total DDDI score was no longer significant, satisfying step 4. Finally, the Sobel test was performed to separately test the mediating effect of anger on NCED, AD, and the total DDDI score. The results showed a mediating effect of anger between perceived stress and NCED (Z = 2.116, p < 0.05), AD (Z = 1.977, p < 0.05), and the total DDDI.

Table 3
Effect of stress and personality traits on driving behavior variables.

<table>
<thead>
<tr>
<th></th>
<th>Beta</th>
<th>S.E.</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative cognitive/emotional driving (NCED)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSS</td>
<td>0.168**</td>
<td>0.073</td>
<td>0.024</td>
</tr>
<tr>
<td>Anger</td>
<td>0.281**</td>
<td>0.616</td>
<td>0.074</td>
</tr>
<tr>
<td>Sensation seeking</td>
<td>0.231**</td>
<td>0.743</td>
<td>0.051</td>
</tr>
<tr>
<td>Altruism</td>
<td>–0.086</td>
<td>0.828</td>
<td>0.007</td>
</tr>
<tr>
<td>Aggressive driving(AD)</td>
<td>0.084**</td>
<td>0.052</td>
<td>0.041</td>
</tr>
<tr>
<td>PSS</td>
<td>0.204**</td>
<td>0.052</td>
<td>0.052</td>
</tr>
<tr>
<td>Anger</td>
<td>0.235**</td>
<td>0.452</td>
<td>0.056</td>
</tr>
<tr>
<td>Sensation seeking</td>
<td>0.242**</td>
<td>0.537</td>
<td>0.056</td>
</tr>
<tr>
<td>Altruism</td>
<td>–0.178**</td>
<td>0.593</td>
<td>0.031</td>
</tr>
<tr>
<td>Risk driving(RD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSS</td>
<td>0.142</td>
<td>0.075</td>
<td>0.020</td>
</tr>
<tr>
<td>Anger</td>
<td>0.145</td>
<td>0.653</td>
<td>0.020</td>
</tr>
<tr>
<td>Sensation seeking</td>
<td>0.405**</td>
<td>0.717</td>
<td>0.159</td>
</tr>
<tr>
<td>Altruism</td>
<td>–0.057</td>
<td>0.854</td>
<td>0.003</td>
</tr>
<tr>
<td>Drunk driving(DD)</td>
<td></td>
<td></td>
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<tr>
<td>PSS</td>
<td>0.199**</td>
<td>0.016</td>
<td>0.039</td>
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<td>Anger</td>
<td>0.071</td>
<td>0.144</td>
<td>0.005</td>
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<td>Sensation seeking</td>
<td>0.146</td>
<td>0.170</td>
<td>0.021</td>
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<tr>
<td>Altruism</td>
<td>–0.167</td>
<td>0.185</td>
<td>0.027</td>
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<tr>
<td>Total DDDI Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSS</td>
<td>0.204**</td>
<td>0.179</td>
<td>0.041</td>
</tr>
<tr>
<td>Anger</td>
<td>0.249**</td>
<td>1.542</td>
<td>0.058</td>
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<tr>
<td>Sensation seeking</td>
<td>0.345**</td>
<td>1.777</td>
<td>0.115</td>
</tr>
<tr>
<td>Altruism</td>
<td>–0.125</td>
<td>2.046</td>
<td>0.015</td>
</tr>
</tbody>
</table>

Note: All regressions were adjusted for age, gender, and number of years driving. All tests are two-tailed. *p < 0.05. **p < 0.01.

Table 4
Hierarchical multiple regression models’ standardized regression coefficients (β).

<table>
<thead>
<tr>
<th></th>
<th>Model 1 (Beta)</th>
<th>Model 2 (Beta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative cognitive/emotional driving (NCED)</td>
<td>0.168**</td>
<td>0.058</td>
</tr>
<tr>
<td>Anger</td>
<td>0.255**</td>
<td>0.049**</td>
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<tr>
<td>Model adjusted R²</td>
<td>0.046</td>
<td>0.092</td>
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<tr>
<td>Aggressive driving (AD)</td>
<td>0.204**</td>
<td>0.127</td>
</tr>
<tr>
<td>Anger</td>
<td>0.178**</td>
<td>0.024**</td>
</tr>
<tr>
<td>Model adjusted R²</td>
<td>0.059</td>
<td>0.079</td>
</tr>
<tr>
<td>Risky driving (RD)</td>
<td>0.142**</td>
<td>0.098</td>
</tr>
<tr>
<td>Anger</td>
<td>0.101</td>
<td>0.010</td>
</tr>
<tr>
<td>Model adjusted R²</td>
<td>0.063**</td>
<td>0.008</td>
</tr>
<tr>
<td>odio adjusted R²</td>
<td>0.047</td>
<td>0.051</td>
</tr>
<tr>
<td>Drunk driving (DD)</td>
<td>0.199**</td>
<td>0.209**</td>
</tr>
<tr>
<td>Anger</td>
<td>–0.023</td>
<td>0.000</td>
</tr>
<tr>
<td>Model adjusted R²</td>
<td>0.054**</td>
<td>0.034</td>
</tr>
<tr>
<td>Total DDDI Score</td>
<td>0.038</td>
<td>0.034</td>
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<tr>
<td>PSS</td>
<td>0.204**</td>
<td>0.120</td>
</tr>
<tr>
<td>Anger</td>
<td>0.195**</td>
<td>0.000</td>
</tr>
<tr>
<td>Model adjusted R²</td>
<td>0.077**</td>
<td>0.029**</td>
</tr>
<tr>
<td>Model adjusted R²</td>
<td>0.061</td>
<td>0.086</td>
</tr>
</tbody>
</table>

Note: All regressions were adjusted for age, gender, and number of years driving. Model 1: perceived stress as a predictor of each subcategory of dangerous driving behavior. Model 2: perceived stress and anger as predictors of each subcategory of dangerous driving behavior. β values were derived from the final step of each model. *p < 0.05. **p < 0.01.
score ($Z = 2.084, p < 0.05$). No mediating effect of anger was found on the relationship between perceived stress and either RD or DD. The mediation models are shown in Fig. 1.

4. Discussion

4.1. Summary of the findings

This study aimed to investigate the individual and joint impact of stress and personality traits on driving behavior. The results showed that global stress was an effective predictor of dangerous driving behavior and that different personality traits had different effects on the four subcategories of the DDDI. Moreover, the effect of stress on dangerous driving behavior was mediated by the personality trait of anger.

Global stress has a significant impact on dangerous driving behavior. The results showed that perceived global stress may be an effective predictor of RD, AD, NCED, and DD. Although the effect of stress on road safety has been demonstrated in previous studies, our research contributes to the literature in two ways. First, our research supported the negative impact of global stress on driving safety. Previous studies have shown the effect of specific external stresses on driving behavior and involvement in accidents. For example, people who were going through a divorce reported involvement in more accidents than those who were not going through a divorce (Lagarde et al., 2004; Mitra-Sarkar and Andreas, 2009; Norris et al., 2000). However, our research measured drivers’ global stress levels, thus expanding the range of stressors. Because the PSS measures individuals’ general perceived stress without providing subjects with a list of specific life events, PSS scores are not biased by events. Second, we measured a greater number of dimensions of driving behavior in this study compared with previous studies. Although previous studies have shown the effect of life events on accident involvement (Lagarde et al., 2004; Norris et al., 2000) as well as RD and AD behavior (Mitra-Sarkar and Andreas, 2009; Rowden et al., 2011), our study adds additional dimensions of self-reported dangerous driving behavior, namely, NCED and DD. NCED refers to driving with feelings of anger, frustration, provocation, and irritation (e.g., losing one’s temper while driving or judging the actions of other drivers as being inappropriate or “stupid”) (Dula and Ballard, 2003; Iliescu and Sarbescu, 2013). According to Baddeley’s (1986, 2001) working memory model, the capacity of general cognitive processing resources is limited. Because worrying is activated in stressful situations (Eysenck, 1992), worrisome thoughts dominate working memory processing and overload the temporary storage capacity of working memory; therefore, an individual’s limited attentional resources are less available for concurrent task processing (Eysenck et al., 2005, 2007). Hence, when stressed drivers are worried and occupied by negative emotions, they place themselves in a more dangerous situation than when their minds are free of such distractions. Stress is a potential contributor to driving risk to the extent that it diminishes the driver’s ability to concentrate on driving. Moreover, the correlation of stress with DD was also revealed in our study. Based on previous results indicating that increased stress leads to increased drinking (Ayer et al., 2011), drivers with higher stress may be more likely to drink and drive. Broadly speaking, the present results enrich and broaden the findings for research on stress and driving safety.

Regarding personality, different personality traits had different effects on dangerous driving behavior. First, sensation seeking was confirmed to be significantly associated with all four subcategories of the DDDI, as has been shown in previous studies (e.g., Arnett, 1990; Dahlen et al., 2005; Dahlen and White, 2006; Jonah, 1997; Schwebel et al., 2006). Sensation seeking is unlikely to be influenced by global stress because no significant correlation between sensation seeking and stress was found in our study. Previous studies have indicated that high sensation seekers do not perceive risky situations to be threatening situations that could lead to negative consequences (Franken et al., 1992; Fischer and Smith, 2004; Roberti, 2004). Smith et al. (1992) also did not find a significant correlation between general stress and sensation seeking; however, they found a positive correlation between negative sport-specific life events and subsequent injury, but only for athletes with low sensation seeking. Smith et al. (1992) indicated that sensation seeking was a stress resiliency factor and suggested that sensation seeking moderated the relationship between life stressors and outcomes only within the same context. Thus, sensation seeking may not be easily influenced by global stress but may be influenced by stress arising from a particular driving situation. Second, our findings support the utility of anger in predicting RD, AD, and NCED, which has also been demonstrated in previous research (e.g., Nesbit et al., 2007; Schwebel et al., 2006). Third, altruism’s ability to predict AD was also shown in this study, which further supports the conclusions of previous studies (Benfield et al., 2007; Dahlen et al., 2012; Ulleberg and Rundmo, 2003). These findings are consistent with our prior research, in which different measures of driving behavior were used (Yang et al., 2013). Moreover, a new finding was obtained in the present study. To our knowledge, the relationship between altruism and DD has not been widely explored. We found that altruism was significantly negatively correlated with DD. Altruism is a trait that is related to individuals’ propensity to be cooperative, kind hearted and actively concerned about others (Goldberg, 1999). The observed relationship between altruism and DD behavior indicates that drivers who are more concerned about others are less likely to drive while intoxicated than those who are less concerned about others.
Finally, the mediating effect of personality traits was explored in this study. The results showed that the effect of stress on NCED and AD was completely mediated by anger. This mediating effect was so strong that the effect of stress on the total DDDI score was also affected. A possible explanation for this result is that stress experienced in everyday life is related to a change in the general propensity to experience anger, which, in turn, can affect driving behavior, especially by increasing negative thoughts and emotions and aggressive behavior while driving. Although previous studies have shown the mediating effect of anger on the relationship between work stress and driving anger (Hoggan and Dollard, 2007; McClinton and Dollard, 2010), our research differs from these studies in two ways. First, the authors of previous studies focused only on work stress in their research. Our study measured global stress rather than any specific type of stress. The advantages of this measure are discussed above. Second, studies on work stress measured driving anger with the driving anger scale (DAS, Deffenbacher et al., 1994), which was used to assess self-reported feelings of anger when drivers encountered several driving situations (Deffenbacher et al., 1994). The NCED subscale of the DDDI that we used measures not only drivers’ feelings of anger but also their behavior (e.g., I drive when I am angry or upset) and thoughts (e.g., I consider the actions of other drivers to be inappropriate or “stupid”) when they drive while angry. The AD subscale of the DDDI measures behavior by which a driver intends to physically or psychologically harm others while driving. Our results showed that drivers with high scores on the trait of anger were more likely to be influenced by stressful situations notwithstanding whether the stress arose from work or life events. Regarding psychological and behavioral outcomes, these drivers showed increased negative thoughts or emotions during driving and aggressive driving behavior while under stress.

4.2. Limitations

This study does have some limitations. One important limitation is that the participants do not constitute a representative sample of Chinese drivers because they were not sampled according to the percentage of the population for the various categories of drivers (e.g., gender, age, number of years driving), which limits our ability to draw conclusions about the entire population of drivers in China. Another limitation is that the data reported in this study were acquired through self-reporting. Although researchers have demonstrated that self-reported data are as useful as archival driving data (Arthur et al., 2005) and data from field studies (Barling et al., 2003; Zacharatos et al., 2005), social desirability remains an interference factor in this type of study. Future studies could be enhanced by integrating self-reported measures with other methods such as field observations and simulated driving. Moreover, some subcategories of the DDDI do not have quantitative descriptions. For example, regarding DD, the amount of consumed alcohol that one would have to exceed to be considered “drunk” was not specified, and participants might have had different responses based on their personal definitions of being “drunk.” Future studies could thus include additional items to more precisely measure this dimension. Moreover, all the data were collected over one time period, eliminating our ability to examine how stress affects driving behavior over time or how personality affects this relationship. Future research should explore driving behavior over a period of time and should provide more evidence from a longitudinal cohort study to explore how stress and personality jointly influence driving behavior.

5. Implications and conclusion

Driving safety is influenced by human factors in various ways. On the one hand, stress is a common state that people confront in everyday life notwithstanding whether there is a specific stressor. Our study demonstrated the negative effects of stress on driving behavior. On the other hand, personality as a stable characteristic was also shown to be an effective predictor of dangerous driving behavior. Moreover, the joint effect of stress and personality was illustrated in this study. The findings confirmed the mediating role of anger in the effect of stress on dangerous driving behavior. This study thoroughly quantified these effects and provided a conceptual model for future research in this area.

The results of this study highlight the need to integrate stress management and anger management together when considering driving safety and any associated interventions. First, global stress, regardless of whether it arises from life events, work, or the driving environment, could induce more dangerous driving behavior. An effective solution to this problem may be to train drivers to realize the dangers of worrying about stressful situations and to help them to develop a set of positive strategies for managing their emotional thoughts. For example, self-awareness exercises that provide biological feedback to drivers about their emotional state could be implemented in training classes. Second, anger management should be included in such a training program given the mediating effect of anger in the relationship between stress and driving behavior. Related courses should present more effective strategies for drivers to manage their anger and to regulate their behavior on the road based on their personality traits. Moreover, driving anger is a typical example of negative emotions while driving. Deffenbacher and his colleagues have developed several instruments to thoroughly explore driving anger, including instruments to assess why people feel angry (the driving anger scale, DAS, Deffenbacher et al., 1994), how they express their anger (the driving anger expression inventory, DAX, Deffenbacher et al., 2002), and what they think when they are angry while driving (the Driver’s Angry Thoughts Questionnaire, DATQ, Deffenbacher et al., 2003). Future studies could systematically explore the influence of stress and personality traits on angry driving behavior. Such investigations could have wide-ranging benefits for the development of personalized driving-related courses for different individuals.

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