



The different effects of personality on prosocial and aggressive driving behaviour in a Chinese sample

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ABSTRACT

Dangerous driving behaviours, as a direct cause of accidents and death, are the focus of considerable research attention. However, unlike unsafe driving behaviours, few studies have explored safe driving behaviours and their effects on road traffic. This study aims to verify the Chinese version of the Prosocial and Aggressive Driving Inventory (PADI) and then investigate the relationship between personality and aggressive/prosocial driving behaviours. A total of 303 licensed drivers were recruited, and they voluntarily and anonymously completed the PADI, the Driving Behaviours Questionnaire (DBQ), and personality scales (anger, sensation-seeking and altruism). The results of this research confirmed the reliability and validity of the Chinese PADI. Most importantly, it was found that different relationships between different personalities and aggressive/prosocial driving behaviours. Specifically, individuals with high altruism exhibited more prosocial driving behaviours, while individuals with high sensation seeking presented more aggressive driving behaviours. The importance of these findings lies in two main potential implications: developing an effective measurement of prosocial driving behaviours in China and providing favourable evidence to guide drivers toward more prosocial driving behaviours.

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1. Introduction

According to the Ministry of Public Security of the People's Republic of China (2017), as of the end of March 2017, the number of registered motor vehicles and motor vehicle drivers in China exceeded 300 million and 364 million, respectively. Although the number of traffic accidents is decreasing, a large increase in the volume of vehicle and drivers means that the total number of accidents remains high and has attracted increasing attention. The National Bureau of Statistics of China (NBSC, 2015) revealed that more than 180 thousand traffic accidents occurred in 2015, resulting in approximately 58 thousand deaths. These accidents and deaths resulted in great harm to many families; they also caused traffic jams and affected other road users. Therefore, an increasing number of people have become concerned about how to promote traffic safety, improve safety awareness and reduce the accident rate (Harre, 2000). Many studies have shown that human factors, especially driving behaviours, have a great influence on the occurrence of accidents (Lewin, 1982; Rumar, 1985; Sabey & Taylor, 1980). For example, many studies have found that aggressive driving behaviours were positively related to the incidence of accidents, penalty points and fines (Castillo-Manzano & Castro-Nuño, 2012; Harris et al., 2014; Hussain, Nayyara, Bradya, Beirne, & Stassen, 2006; Marengo, Settanni, & Vidotto, 2012; Qu, Ge, Jiang, Du, & Zhang, 2014). Empirical evidence shows

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that safe driving behaviours help to improve traffic order and flow, thus promoting traffic safety. However, to date, few studies have explored the impact of positive and safe driving behaviour.

Although only a handful of studies have directly focused on safe driving behaviours, there are many relevant studies addressing factors that have high correlations with safe driving behaviours, such as a safe driving attitude (Martinussen, Sømhovd, Møller, & Siebler, 2015; Ulleberg & Rundmo, 2003), safe driving styles (Kleisen, 2013; Poó, Taubman-Ben-Ari, Ledesma, & Díaz-Lázaro, 2013; Taubman-Ben-Ari, Mikulincer, & Gillath, 2004), safe perceptions (Sullivan, Smith, Horswill, & Lurie-Beck, 2011), positive driving behaviours (Guého, Granié, & Abric, 2014; Özkan & Lajunen, 2005) and less risky behaviour (Ba, Zhang, Peng, et al., 2016; Ba, Zhang, Salvendy, et al., 2016). These studies measured relevant variables and distinguished different types of drivers. Their main goal was to identify effective ways to reduce accidents and promote driving safety. For example, drivers with patient and careful driving styles tended to drive safely and were less likely to be involved in accidents (Poó et al., 2013; Taubman-Ben-Ari et al., 2004). These variables all related to safe driving behaviours, but there were some differences among them. Specifically, safe driving behaviours are more related to specific and comprehensive behaviours than to the purposes (positive driving behaviours), behavioural habits (safe driving styles), consciousness (safe perceptions) or attitudes in relation to driving. However, prosocial driving behaviour (Harris et al., 2014), as a new concept, is a manifestation of safe driving behaviours and emphasizes behaviours in various situations. Therefore, to specifically and thoroughly explore safe driving behaviours, the study of prosocial driving behaviours is a better choice.

To measure prosocial and antisocial driving behaviours together, Harris et al. (2014) created the Prosocial and Aggressive Driving Inventory (PADI). The PADI, a self-report questionnaire, comprehensively measures safe and unsafe driving practices based on the assumption that driving behaviours are stable and continuous characteristics of the drivers. The original PADI included 11 items from the Aggressive Driving Behaviour Scale (ADBS) (Houston, Harris, & Norman, 2003) and 25 items that were created by Harris et al. (2014) based on safe and unsafe driving behaviours described in driving manuals/handbooks. After a principal component analysis with Varimax rotation, 29 items were retained, including 17 items for prosocial driving behaviours (for example, "Decrease speed to accommodate poor weather conditions", "Slow down in a construction zone") and 12 items for aggressive driving behaviours (for example "Make rude gestures at other drivers when they do something I don't like", "Merge into traffic even when another driver tries to close the gap between vehicles") (Harris et al., 2014). Regarding the two dimensions of the PADI, aggressive driving behaviours refer to a pattern of unsafe driving behaviour that puts the driver and other road users in danger (Houston et al., 2003); correspondingly, prosocial driving behaviours refer to a pattern of safe driving behaviours that potentially protect the driver and other road users and help create a safe driving environment (Harris et al., 2014). Although a literature search found no Chinese version of the PADI or similar measurements, this does not mean there is no need for such tools. With the development of research, cross-cultural differences have gained increasing attention (Hilton & Skrutkowski, 2002; Lund & Rundmo, 2009; Ozkan, Lajunen, Chliaoutakis, Parker, & Summala, 2006; Warner, Oezkan, & Lajunen, 2009). On the one hand, population and road condition factors contribute to a more complex traffic environment in China than in America or Western countries (Jiaoyan, Du, Qu, Gong, & Sun, 2013). For example, many unexpected encounters, such as the presence of pedestrians and bicycles, occur on vehicular roads and cause serious road traffic danger in China. On the other hand, differences between Chinese and Americans in the understanding of safe driving is another non-negligible factor. Qualitative studies have found that Chinese drivers consider quick reactions, driving skills and capabilities very important features of safe driving, whereas American drivers concentrate more on safe driving guidelines and are willing to practice on the road rather than going to driving school (Huang, Zhang, Roetting, & Melton, 2006; Zhang, Huang, Roetting, Wang, & Wei, 2006). Therefore, the verification of a valid measurement that is suitable for the Chinese population is very meaningful and indispensable.

Unsafe driving behaviours have been discussed for many years and these behaviours can be measured by numerous scales effectively. The strongly positive relationship between aggressive driving behaviours and accidents has been proven in a series of studies (Castillo-Manzano & Castro-Nuño, 2012; Harris et al., 2014; Hussain et al., 2006; Marengo et al., 2012; Qu et al., 2014). Although few studies have focused on prosocial driving behaviours, Harris et al. (2014) recently found that prosocial driving behaviours could negatively predict accidents and violations. As a result, the relationship between prosocial and aggressive driving behaviours has aroused the interest of researchers. Harris et al. (2014) identified the negative relationship between prosocial driving behaviours and aggressive driving behaviours. Simultaneously, a few studies have found that positive driving behaviours were negatively related to violations, errors and aggressive behaviours (Guého et al., 2014; Özkan & Lajunen, 2005). Additionally, careful and patient driving skills, which are very relevant to safe driving behaviours, were negatively related to risky, high-velocity, dissociative, angry, anxious and distress-reduction driving styles (Poó et al., 2013; Taubman-Ben-Ari et al., 2004). From another perspective, the creation of a theoretical model for safe driving behaviours was conducive to creating a harmonious driving environment that discouraged unsafe driving behaviours.

Regarding individual differences in driving behaviours, personality has always received considerable attention. Several studies have proven that unsafe driving behaviours are positively correlated with some personality traits, such as anger and hostility (Dahlen, Edwards, Tubre, Zyphur, & Warren, 2012; Jiaoyan et al., 2013; Precht, Keinath, & Krems, 2017; Ulleberg & Rundmo, 2003; Zhang & Chan, 2016), sensation seeking (Dahlen, Martin, Ragan, & Kuhlman, 2005; Ge et al., 2014; Gonzalez-Iglesias, Antonio Gomez-Fraguela, & Angeles Luengo, 2014; Marengo et al., 2012; Ulleberg & Rundmo, 2003), normlessness (Jiaoyan et al., 2013; Ulleberg & Rundmo, 2003), and impulsiveness (Dahlen et al., 2005; Marengo et al., 2012; Starkey & Isler, 2016) and are negatively correlated with other personality traits, such as altruism (Ge et al., 2014; Jiaoyan et al., 2013; Mallia, Lazuras, Violani, & Lucidi, 2015; Marengo et al., 2012; Ulleberg & Rundmo, 2003), agreeableness (Benfield, Szlemko, & Bell, 2007; Dahlen et al., 2012; Dahlen & White, 2006; Ulleberg & Rundmo, 2003), and

conscientiousness (Arthur, 2001; Cellar, Nelson, Yorke, & Bauer, 2001; Guo, Wei, Liao, & Chu, 2016). In recent years, safe driving behaviours became a focus of research, and its relationship with personality was further investigated. The results of this research showed that some personality traits are associated with safe driving behaviours; for example, patient and careful driving styles were positively related to self-esteem, agreeableness, conscientiousness, and openness (Taubman-Ben-Ari & Yehiel, 2012; Taubman-Ben-Ari et al., 2004). Additionally, Harris et al. (2014) found that prosocial driving behaviours were positively related to conscientiousness, agreeableness, extraversion and openness. Conversely, safe driving behaviours were negatively related to sensation seeking (Harris et al., 2014; Poó et al., 2013; Taubman-Ben-Ari et al., 2004), aggression-hostility (Harris et al., 2014; Poó et al., 2013), and competitiveness (Harris et al., 2014). Among these personality traits, the most commonly used and representative traits – anger, sensation-seeking and altruism – were chosen for the present study. These three personality traits represent characteristics of Chinese drivers well and are useful indicators for predicting driving behaviours. Concretely speaking, studies with Chinese participants showed that anger and sensation seeking could positively predict dangerous driving behaviours and that altruism could negatively predict dangerous driving behaviours (Ge et al., 2014; Jiaoyan et al., 2013). However, few studies have examined prosocial driving behaviours. Therefore, exploring the relationship between prosocial driving behaviours and the three personality traits was taken into our consideration.

Demographic variables including age, gender, driving experience are important factors that may directly affect driving behaviours. Among these factors, gender has received the most attention in previous studies (Mather, Gorlick, & Lighthall, 2009; Simon & Corbett, 1996). Regarding unsafe driving behaviours, researchers have not obtained completely consistent results. Most studies have shown that males tend to exhibit more unsafe driving behaviours than females; e.g., (Deffenbacher, Deffenbacher, Lynch, & Richards, 2003; Delhomme, Chaurand, & Paran, 2012; Guého et al., 2014; Jiaoyan et al., 2013; Özkan & Lajunen, 2005). However, there are a few studies that did not find a relationship between gender and unsafe driving behaviours (Harris et al., 2014; Li, Yao, Jiang, & Li, 2014; Tao, Zhang, & Qu, 2017), and Taubman-Ben-Ari et al. (2004) even found that females had more dissociative and anxious driving styles than males did. Although there is not much research on safe driving behaviours, their relationship with gender has attracted considerable attention in the existing minority of studies; however, the results were also not very unified. Most studies found that safe driving behaviours were related to gender, with females exhibiting more safe driving behaviours (Harris et al., 2014; Poó et al., 2013; Taubman-Ben-Ari & Yehiel, 2012), while some studies did not find this relationship (Guého et al., 2014; Taubman-Ben-Ari et al., 2004; Özkan & Lajunen, 2005). To explore the effect of personalities on both prosocial and aggressive driving behaviour, gender and other demographic variables were controlled in the present analysis.

There are many reasons to explore prosocial driving behaviour. The first is to perfect the theoretical construct of driving behaviour. Safe and unsafe driving behaviours are both experienced by every driver. Measurements of both aspects of driving practices are necessary (Harris et al., 2014), to develop a full understanding of driving behaviour and to improve the ecological validity of driving behaviour research. The second reason for exploring prosocial driving behaviour is to enhance our understanding of its impact on traffic accidents. Previous studies have found that safe driving behaviours were negatively related to accidents (Harris et al., 2014; Taubman-Ben-Ari et al., 2004) and violations (Harris et al., 2014). Integrating the results of safe and unsafe driving behaviours could improve the overall comprehension of the reason behind accidents. The last reason for studying prosocial driving behaviour is to help drivers avoid accidents by improving their awareness of safe driving and promoting the establishment of a safer driving environment. The research findings regarding safe driving behaviours can correctly and effectively help drivers to understand the importance of safe driving behaviours. Additionally, personality, as a stable individual characteristic, is always a relevant factor in the field of driving psychology. Personality was added as a variable in the present study for two main reasons: First, to verify the relationship between personality and aggressive driving behaviours, and second, to explore the relationship between personality and prosocial driving behaviours.

In summary, there were two main goals in the current study. The first goal was to verify the reliability, construct and criterion validity of the Chinese version of the PADI. The other goal was to investigate the relationship between personality and aggressive/prosocial driving behaviours. Based on the results of previous research and our goals, some hypotheses were posited: (1) The Chinese PADI has a satisfactory reliability and validity. Specifically, prosocial driving behaviours are positively related to positive driving behaviours and negatively related to unsafe (aggressive violations, ordinary violations, errors and lapses) driving behaviours, penalty points and fines; conversely, aggressive driving behaviours are negatively related to positive driving behaviours and positively related to unsafe driving behaviours, penalty points and fines. (2) The PADI has a strong relationship with personality. Furthermore, prosocial driving behaviours can be negatively predicted by anger and sensation seeking and positively predicted by altruism; conversely, aggressive driving behaviours can be positively predicted by anger and sensation seeking and negatively predicted by altruism.

2. Method

2.1. Participants

In the present study, data were collected from 303 Chinese drivers in Beijing. All the participants completed the PADI, the Driving Behaviours Questionnaire (DBQ), the personality scale and items related to traffic accidents and demographic variables. Six participants were eliminated because they chose the same option for all answers on one of the questionnaires; thus, 297 samples (98%) were included in the subsequent analyses. The participants ranged in age from 20 to 56 years

Table 1
Participant demographics (N = 297).

Type	N	Percent (%)
Age groups by gender		
20–30 years old		
Male	69	23.23
Female	40	13.47
31–40 years old		
Male	65	21.89
Females	50	16.83
41–56 years old		
Male	45	15.16
Female	26	8.75
Missing	2	0.67
Driving years		
≤3 years	108	36.36
4–5 years	59	19.87
6–10 years	82	27.61
>10 years	48	16.16
Education		
Below the high school	32	10.77
College and university	162	54.55
The master's degree and PhD	103	34.68
Weekly mileage (KM)		
≤50	62	20.88
51–150	65	21.89
151–400	97	32.66
>400	71	23.91
Missing	2	0.67

($M = 35.02$ years, $SD = 8.57$), and included 180 males (60.6%) and 117 females (39.4%). Table 1 presents the demographic details.

2.2. Measures

2.2.1. The PADI

To promote safety for individuals sharing the road, the PADI was created by Harris et al. (2014) as a self-report questionnaire. The instrument has two dimensions: prosocial (safe) and aggressive (unsafe) driving practices. In total, the PADI has 29 items, including 17 items for prosocial driving behaviours and 12 items for aggressive driving behaviours. The participants were asked to indicate how often they engaged in each of these driving behaviours on a six-point scale (1 = “never”, 2 = “almost never”, 3 = “sometimes”, 4 = “fairly often”, 5 = “very often”, and 6 = “always”).

The Chinese PADI was used in our study. Following the translation/back-translation procedure (Bentler & Bonett, 1980; Regmi, Naidoo, & Pilkington, 2010), we translated the English PADI was translated (Harris et al., 2014) into Chinese. First, the English PADI was translated simultaneously and independently by three researchers, and then a single draft was completed. Second, to ensure that the instrument was accurate and appropriate for Chinese driving culture, the draft was discussed and modified by all the authors. Third, the draft was back-translated by a professional English-Chinese translator to evaluate whether the translation was correct and precise. Finally, based on a group discussion and experienced drivers' opinions regarding clarity and fluency, the Chinese PADI was modified again and finalized.

2.2.2. The DBQ

The DBQ, a self-report questionnaire, was developed by Lawton, Parker, Manstead, and Stradling (1997) to measure aberrant driving behaviours. It has been translated into many languages (Lajunen & Summala, 2003; Xie & Parker, 2002; Yang, Du, Qu, Gong, & Sun, 2013; Özkan, Lajunen, & Summala, 2006). In the present study, to comprehensively examine driving behaviours (Lajunen, Parker, & Summala, 2004), the extended version of the 41-item DBQ was used. This version included 28 items pertaining to aberrant driving behaviours (Lajunen et al., 2004), which were translated by Yang et al. (2013), and 13 items pertaining to positive driving behaviours (Özkan & Lajunen, 2005).

The DBQ used in the present study has five dimensions: positive behaviours (13 items), errors (8 items), lapses (8 items), aggressive violations (3 items) and ordinary violations (9 items). The participants were required to indicate on a six-point scale (1 = “never” to 6 = “Nearly all the time”) how often they were involved in each type of driving behaviour.

2.2.3. The personality scale

This study focused on three personality variables that have been proven to be related to driving safety in China: anger (10 items, $\alpha = 0.83$), sensation-seeking (10 items, $\alpha = 0.78$) and altruism (10 items, $\alpha = 0.73$) (Ge et al., 2014; Yang et al., 2013). All

items were taken from the International Personality Item Pool (IPIP, <http://ipip.ori.org>) (Goldberg et al., 2006), and the definitions of anger, sensation seeking, and altruism were equivalent to those of the NEO Personality Inventory-Revised (Costa & McCrae, 1992). The participants were asked to evaluate the degree to which each description coincided with their ordinary life experiences. All three sub-scales were answered on 5-point Likert scales ranging from “strongly disagree” to “strongly agree”. Higher scores on a sub-scale indicated a stronger presence of the trait.

2.2.4. Demographic variables

Age, gender, level of education, driving years, and weekly mileage were measured. The participants were also asked to report their penalty points, fines over the past year and the number of accidents that they had caused in the past three years, including crashes, rear-ending, side-swiping and so on. For example, one participant lost six points for running a red light.

2.3. Produce

All surveys were distributed and collected via the internet. It was emphasized to all participants that their private information would only be used for scientific research. After completing the surveys voluntarily and carefully, the participants received 20 yuan RMB. The study was approved by the Institutional Review Board of the Institute of Psychology, Chinese Academy of Sciences.

3. Results

3.1. Descriptive statistics and reliability analysis

The means (*M*), standard deviations (*SD*), range (Min-Max) and Cronbach's alpha for the demographic variables, the two subscales of the PADI, the three subscales of the IPIP and the five subscales of the DBQ are shown in Table 1; the descriptive statistics of the 29 PADI items are presented in Table 2. The mean of the prosocial driving sub-scale was 5.35 and ranged from 3.00 to 6.00; meanwhile, the mean of the aggressive driving sub-scale was 2.71 and ranged from 1.00 to 5.33. Obviously, the participants reported prosocial driving behaviours more frequently than aggressive driving behaviours. Additionally, the skew and kurtosis of all items were within the acceptable range.

With the exception of the sensation seeking sub-scale of the IPIP and the positive behaviour sub-scale of the DBQ, the Cronbach's alpha indexes of the other sub-scales were greater than 0.80, which represents good internal consistency reliability (Bryman & Cramer, 1999). Specifically, the Cronbach's alpha index of the two PADI sub-scales were 0.93 for prosocial driving and 0.81 for aggressive driving (Table 2), indicating that the PADI has good internal consistency reliability and was satisfactory for subsequent analyses.

Table 2
Descriptive statistics for demographic variables, the PADI, the IPIP and the DBQ.

Scales	Items	<i>M</i>	<i>SD</i>	Range (Min-Max)	Cronbach's alpha
Demographic variables					
Age		35.01	8.58	20–56	–
Driving years		6.34	5.37	0–30	–
Weekly mileages (KM)		364.44	760.97	0–10,000	–
Accidents		1.31	1.49	0–8	–
Penalty points		2.27	3.05	0–12	–
Fines		237.29	340.62	0–2200	–
The PADI					
Prosocial driving	17	5.35	0.54	3.00–6.00	.93
Aggressive driving	12	2.71	0.75	1.00–5.33	.81
The IPIP					
Anger	10	2.43	0.64	1.00–4.50	.87
Altruism	10	3.96	0.49	2.50–5.00	.81
Sensation Seeking	10	2.65	0.49	1.40–4.30	.64
The DBQ					
Positive behaviour	13	4.55	0.55	2.77–5.69	.69
Aggressive violation	3	2.81	1.17	1.00–6.00	.83
Ordinary violation	9	2.15	0.76	1.00–5.00	.82
Error	8	1.99	0.76	1.00–4.75	.88
Lapse	8	2.31	0.75	1.00–4.75	.80

Note: For penalty points, 6 samples were eliminated because the sum of penalty points was greater than 12.

3.2. Exploratory factor analysis

An exploratory factor analysis (EFA) was administered to verify the construct validity of the Chinese PADI. Because prosocial driving and aggressive driving have an orthogonal relationship, Principal component analysis with fixed two factors and Varimax rotation was used, which is the most common method and is more suitable than oblique rotation (Jolliffe, 2005).

The results revealed that the first factor included 17 items that examined prosocial driving behaviours, and the cumulative incidence rate reached 30.46%; the other factor included 12 items that tapped aggressive driving behaviours, and the cumulative incidence rate reached 45.45%. The items of the two sub-scales were the same as those of the original version of the PADI (Harris et al., 2014), but the loading rates of each item showed discrepancies. To test the discriminative ability of the PADI, the item-total correlations (ITCs) of two sub-scales were tested. All items reached significance level, which indicated that the measurement point of each item and the subjects of the sub-scales had high consistency. The details are shown in Table 3.

3.3. Correlation analysis

As Table 4 shows, external validity was examined in terms of the bilateral correlation between the PADI and the DBQ, accidents, penalty points, fines. Additionally, the relationship between the PADI and the IPIP was measured to verify and explore the relationship between driving behaviour and personality (Dahlen & White, 2006; Taubman-Ben-Ari et al., 2004; Özkan & Lajunen, 2005).

Consistent with expectations, prosocial driving behaviours were negatively associated with aggressive driving behaviours ($r = -0.449, p < 0.01$). The relationships among the PADI and the DBQ, accidents, penalty points, and fines showed that prosocial driving behaviours were positively correlated with the positive behaviours dimension of the DBQ and negatively correlated with other dimensions of the DBQ, penalty points, fines. In contrast, aggressive driving behaviours were negatively correlated with the positive behaviours dimension of the DBQ and positively correlated with other dimensions of the

Table 3

The descriptive statistics and item loading principal component analysis with Varimax rotation for the PADI ($N = 297$).

PADI items	M(SD)	Prosocial driving	Aggressive driving	Communalities	ITCs
20 Pay attention to traffic and my surroundings while driving	5.33(0.73)	0.83		0.70	0.82**
9 Pay special attention when making turns	5.36(0.79)	0.78		0.63	0.79**
29 Drive with extra care around bicyclists	5.44(0.73)	0.75		0.62	0.78**
28 Drive with extra care around pedestrians	5.48(0.69)	0.75		0.62	0.77**
19 Drive more cautiously to accommodate people or vehicles on the side of the road (e.g., slow down, move over)	5.29(0.84)	0.74		0.54	0.72**
23 Use mirrors and check blind spots when changing lanes	5.29(0.78)	0.73		0.55	0.73**
26 Pay special attention when approaching intersections	5.34(0.72)	0.73		0.56	0.74**
12 Maintain a safe distance when following other vehicles	5.34(0.69)	0.72		0.60	0.76**
15 Use turn signals (blinkers) to notify other drivers of my intention to turn	5.62(0.67)	0.72		0.53	0.73**
2 Slow down in a construction zone	5.27(0.81)	0.70		0.53	0.73**
6 Obey traffic signs	5.56(0.64)	0.69		0.56	0.74**
17 Decrease speed to accommodate poor road conditions	5.32(0.79)	0.67		0.47	0.68**
10 Yield when the right of way belongs to other drivers	5.29(0.74)	0.66		0.55	0.72**
1 Decrease speed to accommodate poor weather conditions	5.38(0.80)	0.63		0.41	0.65**
5 Obey posted speed limits in a school zone	5.43(0.80)	0.60		0.41	0.65**
11 Break slowly enough to alert drivers behind me	5.07(0.93)	0.60		0.36	0.59**
14 Come to a complete stop at a stop sign	5.12(0.99)	0.46		0.21	0.48**
21 Speed up when another vehicle tries to overtake me	2.49(1.20)		0.73	0.58	0.74**
25 Weave in and out of lanes to overtake traffic	2.10(1.12)		0.64	0.53	0.70**
8 Accelerate into an intersection when the traffic light is changing from yellow to red	2.39(1.30)		0.63	0.46	0.67**
22 Follow the vehicle in front of me closely to prevent another vehicle from merging in front of me	3.62(1.41)		0.61	0.38	0.57**
27 Flash my high beams at slower vehicle so that it will get out of my way	3.11(1.52)		0.60	0.37	0.61**
7 Honk when another driver does something inappropriate	3.63(1.37)		0.57	0.35	0.52**
4 Merge into traffic even when another driver tries to close the gap between vehicles	1.90(0.99)		0.57	0.42	0.60**
16 Pass other vehicles using the right lane	2.70(1.35)		0.50	0.29	0.55**
3 Make rude gestures at other drivers when they do something I don't like	1.99(1.21)		0.48	0.33	0.54**
18 Drive 15 miles per hour faster than the posted speed limit	2.58(1.43)		0.48	0.25	0.52**
24 Pass in front of a vehicle at less than a car length	2.42(1.38)		0.42	0.27	0.53**
13 Follow a slower vehicle at less than a car length	3.59(1.44)		0.36	–	0.37**
The cumulative incidence rate		30.46%	45.45%		

Note: Communalities less than 0.2 were suppressed.

** $p < 0.01$.

Table 4
Correlations among the full PADI, the IPIP, the DBQ, accidents, penalty points and fines.

	Prosocial	Aggressive	Age	Gender	Ang	Alt	SS	Pos	Ord	Agg	Err	Lap	Acc	Points
Aggressive	−0.449**	1												
Age	0.060	0.016	1											
Gender	0.119 [†]	−0.079	0.003	1										
Anger	−0.308**	0.349**	0.079	0.089	1									
Altruism	0.483**	−0.415**	−0.097	0.037	−0.609**	1								
Sensation-seeking	−0.283**	0.414**	−0.108	−0.131 [†]	0.293**	−0.238**	1							
Positive	0.522**	−0.310**	0.046	0.053	−0.212**	0.309**	−0.115 [†]	1						
Ordinary violations	−0.314**	0.693**	0.001	−0.112	0.415**	−0.354**	0.324**	−0.253**	1					
Aggressive violations	−0.492**	0.786**	0.071	−0.077	0.311**	−0.438**	0.398**	−0.205**	0.521**	1				
Errors	−0.602**	0.521**	−0.049	0.031	0.279**	−0.422**	0.283**	−0.265**	0.285**	0.652**	1			
Lapses	−0.472**	0.449**	0.017	0.206**	0.338**	−0.406**	0.216**	−0.178**	0.272**	0.609**	0.694**	1		
Accidents	−0.087	0.130 [†]	−0.091	−0.048	0.026	−0.073	0.176 [†]	−0.009	0.062	0.096	0.083	0.038	1	
Points	−0.139 [†]	0.239**	0.050	−0.035	0.088	−0.090	0.233**	−0.022	0.152**	0.334**	0.138 [†]	0.193**	0.199**	1
Fines	−0.126 [†]	0.215**	−0.037	−0.074	0.082	−0.114	0.180 [†]	−0.169**	0.141 [†]	0.209**	0.035	0.081	0.198**	0.514**

Notes: Prosocial = Prosocial driving behaviours; Aggressive = Aggressive driving behaviours; Gender: 1 = male, 2 = female; Accidents = Accidents in the last three years; Points = Penalty points received in the last year; Fines = Fines received in the last year.

[†] p < 0.05.

** p < 0.01.

Table 5
Hierarchical regression models of the PADI.

Class variables	Predictive variable in class	Prosocial driving				Aggressive driving			
		Model 1		Model 2		Model 1		Model 2	
		β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>
Demographic variables	Gender	.105	1.766*	.076	1.445 n.s.	-.052	-.873 n.s.	-.017	-.331 n.s.
	Age	.096	1.323 n.s.	.100	1.575 n.s.	-.053	-.722 n.s.	-.029	-.457 n.s.
	Driver year	-.062	-0.840 n.s.	-.023	-.356 n.s.	.116	1.564 n.s.	.074	1.162 n.s.
Personalities	Anger			-.001	-.014 n.s.			.088	1.353 n.s.
	Altruism			.451	7.035***			-.284	-4.455***
	Sensation seeking			-.152	-2.821**			.311	5.809***
The regression model summary	<i>F</i>	1.924		18.315***		1.361		19.132***	
	<i>R</i> ²	.019		.276		.014		.285	
	ΔF	1.924		34.050***		1.361		36.406***	
	ΔR ²	.019		.257		.014		.271	

Note: n.s. $p > .05$.

* $p < .10$.

** $p < .05$.

*** $p < .001$.

DBQ, accidents, penalty points, and fines. Additionally, analysing the relationship between the PADI and the IPIP, it was found that prosocial driving behaviours were positively related to the altruism dimension; negatively related to the anger and sensation seeking dimensions; and inversely related to aggressive driving behaviours. In terms of demographic variables, the results showed that gender had a slightly positive relationship to prosocial driving behaviours. The details are shown in Table 4.

3.4. Hierarchical multiple regression

To explore whether personality variables have an effect on prosocial or aggressive driving behaviours (Lautenschlager & Mendoza, 1986), hierarchical multiple regression (HMR) was used for each subscale. In step 1, the demographic variables were added, including gender, age and driving years, and then the personality variables were added, including anger, altruism, and sensation seeking, in step 2.

Overall, the demographic variables did not reach a significant level of prediction; however, personality variables significantly predicted prosocial and aggressive driving behaviours, accounting for 27.6% and 28.5%, respectively. Specifically, gender marginally predicted prosocial driving behaviour in model 1; in model 2, altruism significantly positively predicted prosocial driving behaviours, while sensation seeking significantly negatively predicted them. The relationships were inverted for aggressive driving behaviours, as shown in Table 5.

HMR was also used to explore whether personality traits and the PADI can predict penalty points and fines under the premise of controlling demographic variables. Step 1 and step 2 were same as those used in the prior HMR, and in step 3, the PADI results were added. The results are presented in Table 6. Personality traits and the PADI significantly predicted penalty points (accounting for 7.0% and 9.4%, respectively) and fines (accounting for 4.1% and 6.1%, respectively). Specifically, sensation seeking in personality traits and aggressive driving behaviours in the PADI could positively predict penalty points and fines.

4. Discussion

The aim of this research was to validate a Chinese version of the PADI and to examine the effect of personality traits on prosocial and aggressive driving behaviours. It was verified that the Chinese version of the PADI has satisfactory reliability and validity. Moreover, the results of correlation and regression analysis demonstrated that the relationship between the PADI and personality were mainly consistent with our hypothesis: prosocial driving behaviours were negatively related to anger and sensation seeking and positively related to altruism. Furthermore, prosocial driving behaviours could be negatively predicted by anger and sensation seeking and positively predicted by altruism, while aggressive driving behaviours showed the opposite relationships with these personality traits.

In the present study, the Chinese version of the PADI showed good reliability and a stable structure, similar to the original version of the PADI (Harris et al., 2014). The Chinese PADI had a relatively high coefficient of internal consistency. This study also found two robust factors, aggressive driving behaviours and prosocial driving behaviours, using EFA analysis. These results suggest that the PADI had acceptable reliability and that its internal structure was adaptive to the context of Chinese traffic. Regarding validity, this study were mainly concerned with two types: congruent/discriminant validity and criterion validity. First, good congruent/discriminant validity of the Chinese PADI was proven in the present study. The correlation analysis of the PADI and the DBQ showed that prosocial behaviours were positively related to positive driving behaviours

Table 6
Hierarchical regression models for penalty points and fines.

Class variables	Predictive variable in class	Penalty points						Fines					
		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
		β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>
Demographic variables	Gender	.064	1.059 n.s.	.093	1.550 n.s.	.099	1.651 n.s.	-.069	-1.144 n.s.	-.051	-.835 n.s.	-.048	-.798 n.s.
	Age	-.036	-.496 n.s.	-.001	-.020 n.s.	.006	.083 n.s.	-.052	-.701 n.s.	-.033	-.448 n.s.	-.028	-.382 n.s.
	Driver year	.146	1.956*	.126	1.715*	.113	1.546 n.s.	.025	.328 n.s.	.009	.121 n.s.	-.005	-.061 n.s.
Personalities	Anger			-.009	-.116 n.s.	-.025	-.331 n.s.			-.012	-.159 n.s.	-.029	-.378 n.s.
	Altruism			-.025	-.334 n.s.	.040	.509 n.s.			-.086	-1.160 n.s.	-.045	-.560 n.s.
	Sensation seeking			.229	3.679***	.167	2.547**			.154	2.468**	.106	1.615 n.s.
The PADI	Prosocial driving					-.046	-.668 n.s.					.009	.127 n.s.
	Aggressive driving					.167	2.378**					.166	2.350**
The regression model summary	<i>F</i>	1.647		3.519**		3.638***		.689		2.040*		2.287**	
	<i>R</i> ²	.017		.070		.094		.007		.041		.061	
	ΔF	1.647		5.316**		3.785**		.689		3.373**		2.946*	
	ΔR^2	.017		.053		.024		.007		.034		.020	

Note: n.s. $p > .05$.

* $p < .10$.

** $p < .05$.

*** $p < .001$.

and negatively related to ordinary violations, aggressive violations, errors and lapses while driving as measured by the DBQ; aggressive driving behaviours had the opposite relationship with prosocial behaviours. This consequence could be explained by the theoretical conception of prosocial and aggressive driving behaviours. Because prosocial and aggressive driving behaviours theoretically yield contrasting results, the items of the two dimensions will naturally present a negative relationship. Second, penalty points and fines were analysed to determine criterion validity. Based on a correlation analysis, penalty points and fines were positively related to aggressive driving behaviours and negatively related to prosocial driving behaviours. Furthermore, regression analysis was used to prove the ability of driving behaviour, measured with the PADI, to predict penalty points and fines when the effect of personality was controlled. Aggressive driving behaviours could positively predict penalty points and fines, but prosocial driving behaviours had no predictive effect. One possible explanation for this discrepancy relates the social background of Chinese traffic. Although [Harris et al. \(2014\)](#) found that prosocial driving behaviours could negatively predict accidents and violations in the USA, previous studies have discovered that environments, driver skill and the overall condition of the cars on the road show a clear gap between China and the USA; specifically, a great many unexpected conditions, such as the presence of pedestrians and non-motor vehicles on the road, are common in China ([Huang et al., 2006](#); [Zhang et al., 2006](#)). Although some drivers have more prosocial driving behaviours, they cannot avoid accidents caused by pedestrians, non-motor vehicles, other drivers and other factors. Furthermore, such accidents may account for a large proportion of all accidents. Another possible explanation relates to the criteria variables. Obviously, penalty points and fines are directly related to unsafe rather than safe driving behaviours. It is very possible that prosocial driving behaviours help to create a safe driving environment, such as by promoting the circulation of traffic and reducing the overall accident rate; however, this effect cannot be precisely represented by individual penalty points and fines. Thus, penalty points and fines are more suitable for assessing the impact of unsafe driving behaviours, while predictions of the results of prosocial driving behaviours need be confirmed in future research by distinguishing the reasons for accidents and using more effective criteria.

This study also explored the relationship between personality traits and the prosocial and aggressive driving behaviours identified in the PADI. In the present study, it was found that prosocial driving behaviours were positively correlated with altruism and negatively correlated with anger and sensation seeking. Inversely, aggressive driving behaviours were positively correlated with anger and sensation seeking and negatively correlated with altruism, which was consistent with our hypothesis. Then, to explore the ability of personality to predict driving behaviours, regression analysis was used while demographic variables were controlled. The results showed that prosocial driving behaviours could be positively predicted by altruism and negatively predicted by sensation seeking; conversely, aggressive driving behaviours could be positively predicted by sensation seeking and negatively predicted by altruism, which is consistent with previous research results ([Delhomme et al., 2012](#); [Ge et al., 2014](#); [Harris et al., 2014](#); [Nesbit & Conger, 2012](#)). In line with our expectations, there was a strong relationship between prosocial driving behaviours and altruism. Our results indicate that drivers with higher altruism will show more prosocial driving behaviours. Altruism is defined as a series of individual characteristics, such as cooperativeness, kind-heartedness, active concerned about others and so on ([Ge et al., 2014](#)). Obviously, altruistic people are more willing to act in ways that benefit other people or society, which is a description of prosocial behaviours ([Eisenberg, Fabes, & Spinrad, 2007](#)). Furthermore, altruistic drivers also show more prosocial driving behaviours, as one type of prosocial behaviour, thus contributing to a safe driving environment. In daily life, although it is difficult to change an individual's personality, it is feasible to encourage drivers to learn the types of prosocial behaviours that altruistic drivers have always displayed. To our surprise, neither type of driving behaviours could be predicted by anger. The reasons that anger cannot predict prosocial driving behaviours may lie in the Chinese cultural background. Empirical evidence shows that numerous Chinese people have a bad temper and a habit of expressing anger. However, this does not imply that anger while driving will directly decrease the driver's prosocial driving behaviours; as the old saying in China goes, "harsh speech, soft heart". The other possibility is that prosocial driving behaviours are not sensitive to anger and that altruism and sensation seeking are more suitable for predicting prosocial driving behaviours. Regarding aggressive driving behaviours, the relationship with anger was confirmed in our analysis and was also proven by previous studies ([Deffenbacher et al., 2003](#); [Ge, Zhang, Zhao, Zhang, & Qu, 2017](#); [Li et al., 2014](#); [Nesbit & Conger, 2012](#)). However, the ability of anger to predict aggressive driving behaviours was not significant, and other existing mediated or moderated variables probably caused this result. Previous studies have identified some mediated variables, such as driving-related anger ([Ge et al., 2017](#); [Kovacsova, Roskova, & Lajunen, 2014](#)), trait rumination ([Suhr & Nesbit, 2013](#)) and thought confidence ([Blankenship, Nesbit, & Murray, 2013](#)). These variables are likely to weaken the direct prediction, and thus future studies should attach greater importance to mediated and moderated variables.

This research is not without limitations. The first limitation related to participant selection. Through a web-based survey, the participants were recruited using convenience sampling. The statistical analysis of the demographic variables indicated that most of the participants were male and young, which may have reduced the representative of the sample. Therefore, future studies should pay increased attention to participant selection. The second limitation relates to variable measurement and the social desirability effect. In this study, driving behaviours, penalty points and fines were assessed using self-report scales without observations or objective measure methods. Such methods may reduce the study's reliability; for example, [Lajunen and Summala \(2003\)](#) found that social desirability can cause bias in driving behaviours. In fact, several cross-cultural studies have proven that Chinese participants are more likely than other nationalities to fake their behaviours and present themselves virtuously ([Fell & König, 2016](#); [Fell, König, & Kammerhoff, 2015](#); [Law, Mobley, & Wong, 2002](#)). Therefore, the use of multiple measurement methods is very necessary.

In conclusion, the Chinese version of the PADI has high reliability and validity. Individuals with high altruism show more prosocial driving behaviours, and individuals with high sensation seeking will present more aggressive driving behaviours. This study has both theoretical and practical implications. Regarding theoretical implications, Bogdan, Măirean, and Havârneanu (2016) noted that most studies in the field of traffic psychology come from the USA; this research not only explored Chinese drivers' behaviours but provides a basis for intercultural comparisons in the field of traffic psychology. This study also has practical implications: Although prosocial driving behaviours have been emphasized in daily life, our results offer powerful evidence to guide drivers to be more concerned about prosocial driving behaviours and promote driving safety.

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References

- Arthur, W. (2001). Predicting motor vehicle crash involvement from a personality measure and a driving knowledge test. *Journal of Prevention & Intervention in the Community*, 22(1), 35–42. https://doi.org/10.1300/J005v22n01_04.
- Ba, Y., Zhang, W., Peng, Q., Salvendy, G., & Crundall, D. (2016). Risk-taking on the road and in the mind: Behavioural and neural patterns of decision making between risky and safe drivers. *Ergonomics*, 59(1), 27–38. <https://doi.org/10.1080/00140139.2015.1056236>.
- Ba, Y., Zhang, W., Salvendy, G., Cheng, A. S. K., & Ventsislavova, P. (2016). Assessments of risky driving: A Go/No-Go simulator driving task to evaluate risky decision-making and associated behavioral patterns. *Applied Ergonomics*, 52, 265–274. <https://doi.org/10.1016/j.apergo.2015.07.020>.
- Benfield, J. A., Szelmeko, W. J., & Bell, P. A. (2007). Driver personality and anthropomorphic attributions of vehicle personality relate to reported aggressive driving tendencies. *Personality and Individual Differences*, 42(2), 247–258. <https://doi.org/10.1016/j.paid.2006.06.016>.
- Bentler, P. M., & Bonnett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, 88(3), 588–606. <https://doi.org/10.1037/0033-2909.88.3.588>.
- Blankenship, K. L., Nesbit, S. M., & Murray, R. A. (2013). Driving anger and metacognition: The role of thought confidence on anger and aggressive driving intentions. *Aggressive Behavior*, 39(4), 323–334. <https://doi.org/10.1002/ab.21484>.
- Bogdan, S. R., Măirean, C., & Havârneanu, C.-E. (2016). A meta-analysis of the association between anger and aggressive driving. *Transportation Research Part F: Traffic Psychology and Behaviour*, 42, 350–364. <https://doi.org/10.1016/j.trf.2016.05.009>.
- Bryman, A., & Cramer, D. (1999). *Quantitative data analysis with SPSS for windows*. London: Quantitative data analysis for social scientists.
- Castillo-Manzano, J. I., & Castro-Nuño, M. (2012). Driving licenses based on points systems: Efficient road safety strategy or latest fashion in global transport policy? A worldwide meta-analysis. *Transport policy*, 21, 191–201. <https://doi.org/10.1016/j.tranpol.2012.02.003>.
- Cellar, D. F., Nelson, Z. C., Yorke, C. M., & Bauer, C. (2001). The five-factor model and safety in the workplace: Investigating the relationships between personality and accident involvement. *Journal of Prevention & Intervention in the Community*, 22(1), 43–52. <https://doi.org/10.1080/10852350109511210>.
- Costa, P. T., & McCrae, R. R. (1992). *Revised NEO personality inventory (NEO-PI-R) and NEO five factor inventory (NEO-FF-I)*. Odessa: Professional Manual, Psychological Assessment Resources Inc.
- Dahlen, E. R., Edwards, B. D., Tubre, T., Zypur, M. J., & Warren, C. R. (2012). Taking a look behind the wheel: An investigation into the personality predictors of aggressive driving. *Accident Analysis and Prevention*, 45, 1–9. <https://doi.org/10.1016/j.aap.2011.11.012>.
- Dahlen, E. R., Martin, R. C., Ragan, K., & Kuhlman, M. M. (2005). Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving. *Accident Analysis and Prevention*, 37(2), 341–348. <https://doi.org/10.1016/j.aap.2004.10.006>.
- Dahlen, E. R., & White, R. P. (2006). The Big Five factors, sensation seeking, and driving anger in the prediction of unsafe driving. *Personality and Individual Differences*, 41, 903–915. <https://doi.org/10.1016/j.paid.2006.03.016>.
- Deffenbacher, J. L., Deffenbacher, D. M., Lynch, R. S., & Richards, T. L. (2003). Anger, aggression, and risky behavior: A comparison of high and low anger drivers. *Behaviour Research and Therapy*, 41(6), 701–718. [https://doi.org/10.1016/s0005-7967\(02\)00046-3](https://doi.org/10.1016/s0005-7967(02)00046-3).
- Delhomme, P., Chaurand, N., Paran, F. o. (2012). Personality predictors of speeding in young drivers: Anger vs. sensation seeking. *Transportation Research Part F: Traffic Psychology and Behaviour*, 15(6), pp. 654–666. <http://doi.org/10.1016/j.trf.2012.06.006>.
- Eisenberg, N., Fabes, R. A., Spinrad, T. L. (2007). *Prosocial development: Handbook of child psychology*. Handbook of Child Psychology.
- Fell, Clemens B., & König, C. J. (2016). Cross-cultural differences in applicant faking on personality tests: A 43-nation study. *Applied Psychology*, 65(4), 671–717. <https://doi.org/10.1111/apps.12078>.
- Fell, C. B., König, C. J., & Kammerhoff, J. (2015). Cross-cultural differences in the attitude toward applicants' faking in job interviews. *Journal of Business and Psychology*, 31(1), 65–85. <https://doi.org/10.1007/s10869-015-9407-8>.
- Ge, Y., Qu, W., Jiang, C., Du, F., Sun, X., & Zhang, K. (2014). The effect of stress and personality on dangerous driving behavior among Chinese drivers. *Accident Analysis and Prevention*, 73, 34–40. <https://doi.org/10.1016/j.aap.2014.07.024>.
- Ge, Y., Zhang, Q., Zhao, W., Zhang, K., & Qu, W. (2017). Effects of trait anger, driving anger, and driving experience on dangerous driving behavior: A moderated mediation analysis. *Aggressive Behavior*. <https://doi.org/10.1002/ab.21712>.
- Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. G. (2006). The international personality item pool and the future of public-domain personality measures. *Journal of Research in Personality*, 40(1), 84–96. <https://doi.org/10.1016/j.jrp.2005.08.007>.
- Gonzalez-Iglesias, B., Antonio Gomez-Fraguela, J., & Angeles Luengo, M. (2014). Sensation seeking and drunk driving: The mediational role of social norms and self-efficacy. *Accident Analysis and Prevention*, 71, 22–28. <https://doi.org/10.1016/j.aap.2014.05.006>.
- Guého, L., Granié, M.-A., & Abric, J.-C. (2014). French validation of a new version of the driver behavior questionnaire (DBQ) for drivers of all ages and level of experiences. *Accident Analysis and Prevention*, 63, 41–48. <https://doi.org/10.1016/j.aap.2013.10.024>.
- Guo, M., Wei, W., Liao, G., & Chu, F. (2016). The impact of personality on driving safety among Chinese high-speed railway drivers. *Accident Analysis and Prevention*, 92, 9–14. <https://doi.org/10.1016/j.aap.2016.03.014>.
- Harre, N. (2000). Risk evaluation, driving, and adolescents: A typology. *Developmental Review*, 20(2), 206–226. <https://doi.org/10.1006/drev.1999.0498>.
- Harris, P. B., Houston, J. M., Vazquez, J. A., Smither, J. A., Harms, A., Dahlke, J. A., & Sachau, D. A. (2014). The prosocial and aggressive driving inventory (PADI): A self-report measure of safe and unsafe driving behaviors. *Accident Analysis and Prevention*, 72, 1–8. <https://doi.org/10.1016/j.aap.2014.05.023>.
- Hilton, A., & Skrutkowski, M. (2002). Translating instruments into other languages: Development and testing processes. *Cancer Nursing*, 25(1), 1–7. <https://doi.org/10.1097/00002820-200202000-00001>.
- Houston, J. M., Harris, P. B., & Norman, M. (2003). The aggressive driving behavior scale: Developing a self-report measure of unsafe driving practices. *North American Journal of Psychology*, 5(2), 269–278.
- Huang, Y.-H., Zhang, W., Roetting, M., & Melton, D. (2006). Experiences from dual-country drivers: Driving safely in China and the US. *Safety Science*, 44(9), 785–795. <https://doi.org/10.1016/j.ssci.2006.05.002>.

- Hussain, O. T., Nayyara, M. S., Bradya, F. A., Beirne, J. C., & Stassen, L. F. A. (2006). Speeding and maxillofacial injuries: Impact of the introduction of penalty points for speeding offences. *British Journal of Oral & Maxillofacial Surgery*, 44(1), 15–19. <https://doi.org/10.1016/j.bjoms.2005.07.015>.
- Jiaoyan, Y., Du, F., Qu, W., Gong, Z., & Sun, X. (2013). Effects of personality on risky driving behavior and accident involvement for Chinese drivers. *Traffic Injury Prevention*, 14(6), 565–571. <https://doi.org/10.1080/15389588.2012.748903>.
- Jolliffe, I. T. (2005). *Principal component analysis*. Springer: Verlag.
- Kleisen, L. M. B. (2013). A positive view on road safety: Can 'car karma' contribute to safe driving styles? *Accident Analysis and Prevention*, 50, 705–712. <https://doi.org/10.1016/j.aap.2012.06.022>.
- Kovacsova, N., Roskova, E., & Lajunen, T. (2014). Forgiveness, anger, and hostility in aggressive driving. *Accident Analysis and Prevention*, 62, 303–308. <https://doi.org/10.1016/j.aap.2013.10.017>.
- Lajunen, T., Parker, D., & Summala, H. (2004). The Manchester Driver Behaviour Questionnaire: A cross-cultural study. *Accident Analysis & Prevention*, 36(2), 231–238. [https://doi.org/10.1016/s0001-4575\(02\)00152-5](https://doi.org/10.1016/s0001-4575(02)00152-5).
- Lajunen, T., & Summala, H. (2003). Can we trust self-reports of driving? Effects of impression management on driver behaviour questionnaire responses. *Transportation Research Part F: Traffic Psychology and Behaviour*, 6(2), 97–107. [https://doi.org/10.1016/s1369-8478\(03\)00008-1](https://doi.org/10.1016/s1369-8478(03)00008-1).
- Lautenschlager, G. J., & Mendoza, J. L. (1986). A step-down hierarchical multiple regression analysis for examining hypotheses about test bias in prediction. *Applied Psychological Measurement*, 10(2), 133–139.
- Law, K. S., Mobley, W. H., & Wong, C.-S. (2002). Impression management and faking in biodata scores among Chinese job-seekers. *Asia Pacific Journal of Management*, 19(4), 541–556.
- Lawton, R., Parker, D., Manstead, A. S. R., & Stradling, S. G. (1997). The role of affect in predicting social behaviors: The case of road traffic violations. *Journal of Applied Social Psychology*, 27(14), 1258–1276.
- Lewin, I. (1982). Driver training: A perceptual-motor skill approach. *Ergonomics*, 25(10), 917–924. <https://doi.org/10.1080/00140138208925051>.
- Li, F., Yao, X., Jiang, L., & Li, Y. (2014). Driving anger in China: Psychometric properties of the Driving Anger Scale (DAS) and its relationship with aggressive driving. *Personality and Individual Differences*, 68, 130–135. <https://doi.org/10.1016/j.paid.2014.04.018>.
- Lund, I. O., & Rundmo, T. (2009). Cross-cultural comparisons of traffic safety, risk perception, attitudes and behaviour. *Safety Science*, 47(4), 547–553. <https://doi.org/10.1016/j.ssci.2008.07.008>.
- Mallia, L., Lazaras, L., Violani, C., & Lucidi, F. (2015). Crash risk and aberrant driving behaviors among bus drivers: The role of personality and attitudes towards traffic safety. *Accident Analysis and Prevention*, 79, 145–151. <https://doi.org/10.1016/j.aap.2015.03.034>.
- Marengo, D., Settanni, M., & Vidotto, G. (2012). Drivers' subtypes in a sample of Italian adolescents: Relationship between personality measures and driving behaviors. *Transportation Research Part F: Traffic Psychology and Behaviour*, 15(5), 480–490. <https://doi.org/10.1016/j.trf.2012.04.001>.
- Martinussen, L. M., Sømshovd, M. J., Møller, M., & Siebler, F. (2015). A Go/No-go approach to uncovering implicit attitudes towards safe and risky driving. *Transportation Research Part F: Traffic Psychology and Behaviour*, 30, 74–83. <https://doi.org/10.1016/j.trf.2015.02.005>.
- Mather, M., Gorlick, M. A., & Lighthall, N. R. (2009). To brake or accelerate when the light turns yellow? Stress reduces older adults' risk taking in a driving game. *Psychological Science*, 20(2), 174–176. <https://doi.org/10.1111/j.1467-9280.2009.02275.x>.
- Nesbit, S. M., & Conger, J. C. (2012). Predicting aggressive driving behavior from anger and negative cognitions. *Transportation Research Part F-Traffic Psychology and Behaviour*, 15(6), 710–718. <https://doi.org/10.1016/j.trf.2012.07.003>.
- Özkan, T., Lajunen, T. (2005). A new addition to DBQ: Positive driver behaviours scale. *Transportation Research Part F* 8(4–5), pp. 355–368. <http://doi.org/10.1016/j.trf.2005.04.018>.
- Özkan, T., Lajunen, T., Chliaoutakis, J. E., Parker, D., & Summala, H. (2006). Cross-cultural differences in driving behaviours: A comparison of six countries. *Transportation Research Part F-Traffic Psychology and Behaviour*, 9(3), 227–242. <https://doi.org/10.1016/j.trf.2006.01.002>.
- Özkan, T., Lajunen, T., & Summala, H. (2006). Driver behaviour questionnaire: A follow-up study. *Accident Analysis and Prevention*, 38(2), 386–395. <https://doi.org/10.1016/j.aap.2005.10.012>.
- Poó, F. M., Taubman-Ben-Ari, O., Ledesma, R. D., & Díaz-Lázaro, C. M. (2013). Reliability and validity of a Spanish-language version of the multidimensional driving style inventory. *Transportation Research Part F: Traffic Psychology and Behaviour*, 17, 75–87. <https://doi.org/10.1016/j.trf.2012.10.003>.
- Precht, L., Keinath, A., & Krems, J. F. (2017). Effects of driving anger on driver behavior – Results from naturalistic driving data. *Transportation Research Part F: Traffic Psychology and Behaviour*, 45, 75–92. <https://doi.org/10.1016/j.trf.2016.10.019>.
- Qu, W., Ge, Y., Jiang, C., Du, F., & Zhang, K. (2014). The dula dangerous driving index in China: An investigation of reliability and validity. *Accident Analysis and Prevention*, 64C(3), 62–68. <https://doi.org/10.1016/j.aap.2013.11.004>.
- Regmi, K., Naidoo, J., & Pilkington, P. (2010). Understanding the processes of translation and transliteration in qualitative research. *International Journal of Qualitative Methods*, 9(1), 16–26.
- Rumar, K. (1985). The role of perceptual and cognitive filters in observed behavior. In L. Evans & R. C. Schwing (Eds.), *Human behavior and traffic safety* (pp. 151–170). Boston, MA: Springer, US.
- Sabey, B. E., & Taylor, H. (1980). *The known risks we run: The highway*. Springer, US.: Societal Risk Assessment.
- Simon, F., & Corbett, C. (1996). Road traffic offending, stress, age, and accident history among male and female drivers. *Ergonomics*, 39(5), 757–780. <https://doi.org/10.1080/00140139608964497>.
- Starkey, N. J., & Isler, R. B. (2016). The role of executive function, personality and attitudes to risks in explaining self-reported driving behaviour in adolescent and adult male drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 38, 127–136. <https://doi.org/10.1016/j.trf.2016.01.013>.
- Suhr, K. A., & Nesbit, S. M. (2013). Dwelling on 'Road Rage': The effects of trait rumination on aggressive driving. *Transportation Research Part F-Traffic Psychology and Behaviour*, 21, 207–218. <https://doi.org/10.1016/j.trf.2013.10.001>.
- Sullivan, K. A., Smith, S. S., Horswill, M. S., & Lurie-Beck, J. K. (2011). Older adults' safety perceptions of driving situations: Towards a new driving self-regulation scale. *Accident Analysis and Prevention*, 43(3), 1003–1009. <https://doi.org/10.1016/j.aap.2010.11.031>.
- Tao, D., Zhang, R., & Qu, X. (2017). The role of personality traits and driving experience in self-reported risky driving behaviors and accident risk among Chinese drivers. *Accident Analysis and Prevention*, 99, 228–235. <https://doi.org/10.1016/j.aap.2016.12.009>.
- Taubman-Ben-Ari, O., Mikulincer, M., & Gillath, O. (2004). The multidimensional driving style inventory—Scale construct and validation. *Accident Analysis and Prevention*, 36(3), 323–332. [https://doi.org/10.1016/s0001-4575\(03\)00010-1](https://doi.org/10.1016/s0001-4575(03)00010-1).
- Taubman-Ben-Ari, O., & Yehiel, D. (2012). Driving styles and their associations with personality and motivation. *Accident Analysis and Prevention*, 45, 416–422. <https://doi.org/10.1016/j.aap.2011.08.007>.
- Ulleberg, P., & Rundmo, T. (2003). Personality, attitudes and risk perception as predictors of risky driving behaviour among young drivers. *Safety Science*, 41(5), 427–443. [https://doi.org/10.1016/s0925-7535\(01\)00077-7](https://doi.org/10.1016/s0925-7535(01)00077-7).
- Warner, H. W., Oezkan, T., & Lajunen, T. (2009). Cross-cultural differences in drivers' speed choice. *Accident Analysis and Prevention*, 41(4), 816–819. <https://doi.org/10.1016/j.aap.2009.04.004>.
- Xie, C.-Q., & Parker, D. (2002). A social psychological approach to driving violations in two Chinese cities. *Transportation Research Part F: Traffic Psychology and Behaviour*, 5(4), 293–308. [https://doi.org/10.1016/s1369-8478\(02\)00034-7](https://doi.org/10.1016/s1369-8478(02)00034-7).
- Yang, J., Du, F., Qu, W., Gong, Z., & Sun, X. (2013). Effects of personality on risky driving behavior and accident involvement for Chinese drivers. *Traffic Injury Prevention*, 14(6), 565–571. <https://doi.org/10.1080/15389588.2012.748903>.
- Zhang, T., & Chan, A. H. (2016). The association between driving anger and driving outcomes: A meta-analysis of evidence from the past twenty years. *Accident Analysis and Prevention*, 90, 50–62. <https://doi.org/10.1016/j.aap.2016.02.009>.
- Zhang, W., Huang, Y. H., Roetting, M., Wang, Y., & Wei, H. (2006). Driver's views and behaviors about safety in China – What do they NOT know about driving? *Accident Analysis and Prevention*, 38(1), 22–27. <https://doi.org/10.1016/j.aap.2005.06.015>.