Traffic safety climate factors in explaining driving behaviours and traffic crash involvement: comparative study among male and female drivers

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Key Findings

- Male and female drivers expressed different perceptions about traffic safety climate, driving behaviour and traffic crash;
- External affective demand is positively related to aberrant driving behaviour but negatively related to positive driving behaviour;
- Internal requirement and Functionality are positively related to positive driving behaviour;
- Internal requirement and Functionality are negatively related to aberrant driving behaviour;

Abstract

The study examined the explanatory power of Traffic Safety Climate factors in driving behaviours and the probability of traffic crash involvement among male and female drivers in China, taking into consideration different clusters of age. A total of 887 license drivers aged between 24 and 64 completed Chinese version of traffic climate scale, driving behaviours scale, and crash involvement. Multivariate regression analyses were conducted. The result established that male driver's, reported high emotional engagement, driving violations and traffic crashes than female drivers. Perceived external affective demand (EAD) was more likely to be related to aberrant driving behaviours (ADB), but less likely to be related to positive driving behaviour (PDB) with young and middle-aged male drivers more affected. Perceived EAD was less likely to be associated with ADB and traffic crash involvement of female older drivers. The perceived internal requirement was positively related to PDB, but negatively related to ADB for both sexes with young females expressing high PDB and low probability of traffic crash involvement than male drivers. Perceived traffic system functionality (FUN) was negatively related to ADB, but positively related to PDB for both sexes with male drivers in all age brackets expressing more PDB. As a remedial measure, traffic authorities have to direct their attention towards the modification of traffic infrastructure designs.

Keywords

Traffic climate safety, aberrant driving behaviours, positive driving behaviour, sex, traffic crashes

Introduction

Road traffic crashes pose a serious threat to traffic safety and are the 8th leading cause of death for people of all age groups, but the number one cause of death for young adults (World Health Organisation, 2018). According to World Health Organisation report, the number of people that lose their lives through road accidents remains unacceptably high with 1.35 million people dying each year (World Health Organisation, 2018). In the same report, it was revealed that 18.2 persons per 100 000 are killed in China Road traffic crashes as against countries like the UK 3.1,

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Canada 5.8, Austria 5.2, Denmark 4.0, Germany and Italy 4.1, Israel 4.2 and 12.4 persons per 100 000 population for the USA.

Although China has introduced several intervention measures such as improvement of transportation infrastructure (Lijun Wang 2019), the use of trains and ships (National Bureau of Statistics of China, 2010), public education programmes and enforcement of legislation to improve road traffic safety, studies have shown that road traffic crashes remain the leading cause of injury and death in China (Wong, 2020; Zhang et al. 2011). In 2018 alone, China recorded 258,532 injuries and 63,194 fatalities in traffic crash across the country (Wong, 2020; Zhang et al 2021). The increasing number of traffic crashes are linked to the drivers' disregard for traffic safety (Chu et al. 2019, Zhang et al. 2018; Yeşim Üzümcüoğlu Zihni, 2018). The condition of a traffic system also guides driving behaviours (Pousette, Larsson & Törner, 2008), which could contribute to road traffic accidents (Özkan & Lajunen, 2005b). Therefore, the perception of Traffic Safety Climate (TSC) could direct behaviours of a road user and a driver's risk of being involved in a traffic crash may be linearly dependent on exposure to different traffic conditions. Besides, in a study that attempts to evaluate the importance of TSC in promoting safe driving, sex is one of the significant factors that has to be considered (Özkan & Lajunen, 2015). Therefore, the present study mainly aims to examine the explanatory power of perceived TSC factors in driving behaviours and the probability of traffic crash involvement among male and female drivers in China, taking into consideration different clusters of age. The findings from the study would aid in identifying a group of drivers involved in particular driving behaviour and traffic crash in a specific traffic condition for developing appropriate measures directed towards such group.

Traffic Safety Climate (TSC)

The perception of TSC plays an important role in road safety issues as it guides the behaviours of drivers (Pousette, Larsson & Törner, 2008). It may include both the amount of driving and the road conditions under which the driving takes place (Laapotti, Keskinen & Rajalin, 2003). In a recent development, the TSC scale with its definition developed by Özkan & Lajunen (2011) has attracted researchers' attention. It has been defined as "the driver's perceptions of the traffic in a context at a given point in time which is subjected to change depending on the features of the traffic environment or conditions that can affect the skills, attitude and drivers' behaviour" (Chu et al . 2019).

The Traffic Climate Scale has been translated into German (Gehlert et al., 2014), Chinese (Chu et al. 2019; Zhang et al., 2018) and Lithuanian (Marksaityte et al., 2014). These studies performing exploratory factor analysis confirmed the three-factor structure representing external affective demands, internal requirements and functionality with high reliability and satisfactory internal validity. The external affective demands describe the emotional engagement of road users (e.g., "aggressive," "time consuming," "putting pressure," and "dangerous") when participating in traffic. The internal requirements factor

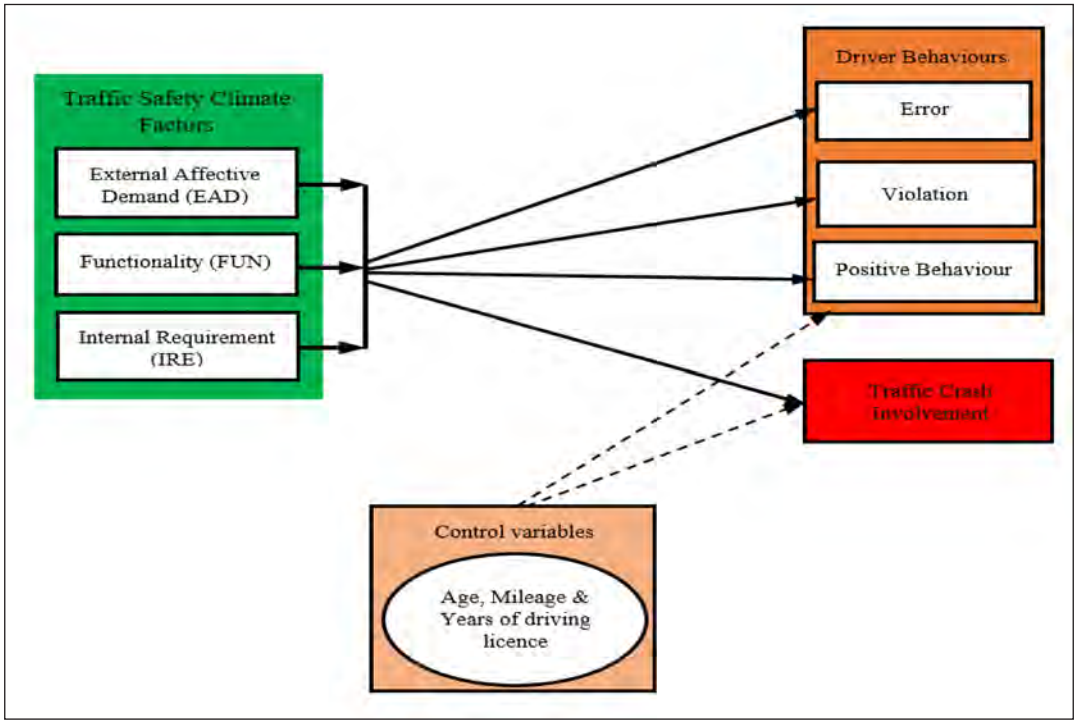

Figure 1. The Conceptual Framework

refers to cognitive and social requirements describing road users' skills and abilities (e.g., "require experience," "require cautiousness," "require vigilance," "Require patience") to effectively participate in traffic. Functionality factor describes perceived requirements for a functional traffic system that describe the state of the traffic facilities and environment (e.g., "Planned," preventive measures," "dependent on mutual consideration," "Pleasant").

The original structure of Traffic Safety Climate was based on organisational climate, as there are similarities between the two scales. The organisational climate scale comprises affective, cognitive and instrumental components (De Simone, 2014). The development of TSC (external affective demands, internal requirements, and functionality) correspond to the three components of organisational safety climate (Zhang et al 2018).

Driver's Behaviour (DB)

The analyses of traffic accidents indicate that the component of the traffic system also includes human factors which are the major contributory factors in road traffic accidents (e.g., Sagberg et al 2015; Atombo, Wu, Zhong, & Zhang, 2016). Human factors in driving can be seen as being composed of two separate components, driving skills and driving style (Bener et al., 2008). Driving style concerns individual driving habits, i.e., the way a driver chooses to drive. It can be assumed therefore, that male and female drivers should have different driving styles in traffic (Sagberg et al 2015).

One of the most commonly used tools for measuring aberrant driving behaviours is the Driver Behaviour Questionnaire (DBQ) (Reason, Manstead, Stradling, Baxter & Campbell, 1990). DBQ was extended to cover positive driver behaviours (Özkan & Lajunen, 2005a). Aberrant and positive behaviour are two sides of driving behaviour (Özkan & Lajunen, 2005a). They usually occur concurrently in traffic conditions (Shen et al., 2018). The DBQ primarily reflects the difference between errors (example: fail to notice pedestrians are crossing) and violations (example: race away from traffic lights, disregard the speed limit on a residential road).

The driving error was defined as "all those instances in which a planned sequence of a cognitive decision or physical activities fail to achieve its intended outcome" (Reason et al., 1990). Errors may result from activities that are improper in a given circumstance or are appropriate but executed wrongly (Sucha, Sramkova & Risser, 2014). Errors are unintentional behaviour, separated into slips and lapses according to the potential outcome of the error. Lapses mostly involve failures of memory while slips are associated with attention deficits that do not lead to an increased risk of crash involvement (Stephens & Fitzharris, 2016).

Violations are intentional aberrations, closely related to personality characteristics, attitudes, and social context which intentionally disobey safe driving practices (Stephens & Fitzharris, 2016). It is still possible for a driver to commit violations without errors or commit errors without violations. Violations have been categorised into ordinary and aggressive violations, based on the motive for which a driver commits a violation (e.g., Lawton, Parker, Manstead & Stradling, 1997). In addition, higher scores of violations are associated with increased motor vehicle crash involvement (De Winter & Dodou, 2010; Nordfjærn, Şimşekoğlu & Rundmo, 2014). In this present study, it is expected that these violations could be influenced by the conditions or situations in physical traffic environments.

Özkan & Lajunen (2005a) put forward that, in everyday driving, there are positive behaviours that cannot be classified as errors or violations. Given that, positive behaviour is not based on coded rules and guidelines, or consider safety, rather deal with the situations in traffic and to be well-mannered. These ''positive'' behaviours can be committed without a violation or an error if the action and the plan were adequate for achieving the intended target. Positive driving behaviour has underlying good intentions, but may sometimes include errors or violations when the intended planned actions are not achieved. In this study, a positive driver's behaviour towards traffic safety climate is defined as the capability of a driver interacting effectively with other road users in the driving environment.

Traffic Safety Climate, Driver Behaviour and Road Traffic Crash

Traffic safety climate is a "paradigm" for explaining observed road traffic crash and risky driving behaviours" (Ward, Linkenbach, Keller & Otto, 2010; Özkan & Lajunen, 2015). In order to achieve a safe driving environment, drivers have to effectively interact with other road users and take one another actions and behaviour into consideration. Drivers use the traffic conditions as a source of information to communicate with the physical driving environments and other road users. However, the condition of traffic might pose difficulties to drivers' performance and attainment of plans. This could generate frustration and induce aberrant behaviours which could increase the risk of crash involvements (Danaf, 2018).

Studies have applied Safety Climate factors in predicting traffic-related behaviours (Wills et al., 2006; Amponsah-Tawiah and Mensah, 2016). For instance, the study of Wills et al. (2006) found that safety climate factors correlated with safe *driving* behaviour. In the work of Amponsah-Tawiah and Mensah, (2016), safety climate predicted safe work-related driving behaviours.

Researchers in the domain of traffic safety have also acknowledged the importance of applying TSC factors in predicting driving-related behaviours (Lee et al., 2016; Schlembach et al., 2016) and crash involvement (Özkan & Lajunen, 2015) as depicted in ***Figure 1***. However, few

studies have explored the relationship between traffic safety climate and driving behaviour as well as crash involvement (Chu et al., 2019; Gehlert et al. 2014; Zhang et al., 2018). The work of Gehlert et al. (2014) postulated that the less emotionally and cognitively demanding and the more functional driver's perceived traffic systems to be, the less risky and safer road users feel in traffic. However, the result of the study revealed that traffic violation increases when traffic systems are perceived to be functional and required less skills. The authors also found internal requirements of drivers to be associated with driving style. In another study, Zhang et al. (2018), tested the mediating effect of traffic safety climate between personality and dangerous driving behaviour. They found traffic climate mediating the effect of personality on dangerous driving behaviour.

The study of Chu et al. (2019) found a relationship between TSC, driver behaviour factors and traffic accidents involvement. In particular, their result shows that the external affective demand was positively related to aberrant behaviours and negatively related to positive behaviours whereas functionality and internal requirements were found to be negatively related to aberrant behaviours and positively related to positive behaviours. The same study (Chu et al. 2019), found functionality negatively related to accident involvement whereas external affective demand positively related to accident involvement. The study further indicated that a driver with a positive driving behaviour would interact effectively with drivers and pedestrians in all traffic conditions. These findings are indispensable; however, it does not reveal which sex or age group is more likely to be engaged in a certain driving behaviour and traffic crash involvement. As such, it is imperative to conduct this research.

Sex Characteristic

Sex (male and female) of drivers is one of the influential factors to be considered in a study that attempts to evaluate traffic safety climate to promote safe driving (Marksaityte et al., 2014; Gehlert et al., 2014). In Traffic safety research, it has been evidenced that the behaviours and the crash risks of male and female drivers are different (Harrison, 2009). However, globally, only a few studies have explored the traffic safety climate in relation to sex characteristics. The study of Marksaityte et al., (2014) found traffic safety climate factors and higher accident risk are related to sex. In that study, it was revealed that men reported a more positive attitude towards traffic safety climate than women. The study further revealed that female drivers who had been involved in at least one traffic accident perceived the traffic system as more functional. In another study, positive behaviours of men are predicted by cycling intensity, knowledge of traffic rules and risk perception (Useche et al., 2018).

Similarly, Alfonsi et al. (2018) revealed that the majority of drivers involved in traffic crashes in every country are virtually male drivers. Apart from males being over-represented in accident statistics, male drivers especially young men are also more inclined to commit more violations in traffic than their female counterparts (Jonah, 1990). Other studies have found sex differences in risky driving behaviours with male drivers found to be engaging in risky driving behaviours more frequently in traffic and are at a higher risk of crashing than female drivers (Harrison, 2009; Rhodes & Pivik, 2011). The study of Useche et al., (2021) revealed that road users risk perception and misbehaviours are significant predictors of male pedestrians. On the other hand, female drivers, commit more errors than male drivers (Parker, McDonald, Rabbitt & Sutcliffe, 2000; De Winter et al 2010) especially, when there are distractions in traffic (Useche et al., 2021). However, female drivers psychological distress predicts positive driving behaviours (Useche et al. 2018). Others have also found females being safer drivers with positive driving behaviour characteristics in traffic than males (Özkan & Lajunen, 2006). Despite these findings on sex characteristics, no study has explored the role of traffic safety climate in explaining driving behaviour-related factors and the probability of traffic crash involvement among male and female drivers in China. Therefore, predicting driver behaviour and crash involvement using traffic climate safety factors have to be tested across male and female drivers in China.

In the study of this nature, it is important to investigate the differences among different age groups of both sex driving behaviours and the probability of crash involvement. This is because, age has been identified as having independent effects on driving behaviour and driving safety (Shinar, 2017). Age has further been recognised as a significant factor to be considered in any attempt to promote safe driving (Shinar, 2017). Studies have previously indicated that younger drivers especially males constitute the age group with the highest rates of aberrant driver behaviours (e.g., de Winter & Dodou, 2010; Martinussen et al., 2014) and crash involvement in traffic compared to older drivers (Ouimet et al., 2010; Hassan, 2016). This group of drivers tend to overestimate their ability and underestimate traffic hazards (Alfonsi et al. 2018). Rhodes & Pivik, (2011) also found that teen drivers often engage in risky driving behaviours in traffic than adult drivers.

The rationale for the Study

The study examining the explanation power of Traffic Safety Climate factors in driving behaviours and the probability of traffic crash involvement among male and female drivers in China is warranted because, there is an increasing population of vehicles and drivers in China. According to statistics, as of September, 2020, China had 365 million motorized vehicles registered for use on roads and a total of 450 million licensed drivers (Ministry of Public Security, 2020). The increase in the number of vehicles on roads could stimulate different driving behaviours and affect

road crashes. Based on this, authorities have employed traffic rules that are different from what pertains to other countries (Zhang 2018). In addition, the effect of traffic safety climate on driving behaviours and traffic fatalities in China could be different from that of other countries. For instance, studies have shown that traffic environment influences Chinese drivers to exhibit different driving styles which results into high number of crashes than those in the United States and Japan (Atchley et al., 2014; Zhang et al., 2010). In another study, it was reported that Chinese drivers exhibited a lower level of anger in response to driving violations in traffic than drivers in America, New Zealand and Spain Li et al., 2014). Although studies have explored the relationship between TSC factors and driver's behaviour as well as accidents involvement across countries, no research has considered the sex characteristic. In addition, even though, the previous findings are important, but still lack evidence to conclude that drivers with certain sex characteristics are more likely to be involved in a particular driving behaviour and traffic crashes. As such, the association between traffic safety climate and drivers' behaviours as well as crash involvements among male and female drivers is required in order to develop appropriate safety measures directed towards a particular group of drivers.

Methods and Materials

Procedure and Participants

A web-based data collection method was used with an assistance of a professional research company in China. The participation was done voluntarily with confidentiality and anonymity assurance. A random sampling technique was used to select 908 drivers covering 27 provinces of China. The random sampling was realised by contacting the participants through the mail and were asked to complete the survey on the Web. After cleaning the data, a total of 887 valid samples were retained, representing approximately 98% of the total questionnaire administered with a minimum of 29 and a maximum of 35 respondents from each of the selected provinces.

The participants included were drivers who held valid driving licenses at the time of the study. The participants included male (N= 531) and female (N=356) drivers. The age of the drivers ranges from 24 to 64 and the mileage ranges from 16000 to 1100000. Furthermore, the year of driving license is between 5 and 36 years and the total number of traffic crashes ranges from 0 to 6. The mean score and the standard deviation of the characteristics of the whole study samples are presented in Table 1. In all the characteristics variables, male drivers score higher and had high annual mileage and traffic crashes than their female counterparts.

Table 1. Demographic characteristics of the sample

Items	Total Sample	Female Sample	Male Sample
Number of respondents	887	356	531
Age			
Mean	44.58	42.93	45.70
SD	7.5	5.94	8.21
Total Mileage (×1000)			
Mean	95.19	85.97	104.40
SD	105.47	99.85	110.94
Years of Driving License			
Mean	5.72	4.81	6.61
SD	4.99	3.83	5.55
Road Traffic Crashes			
Mean	1.22	1.07	1.33
SD	1.11	1.00	1.17

Materials

It is important to note that this study used the validated version of the Chinese Traffic Safety Climate scale and the Driver Behaviour Questionnaire scale that was previously validated on the same sampled population of drivers and published by the authors (refer to Chu et al. 2019 for detail on how the questionnaire tool was validated to adapt to the sociocultural settings in China). In our previous work, we used the forward-and-back translation method to translate the English versions of Traffic Climate Scale (TCS) and Driver Behaviour Scales to Chinese with the support of two different and independent translation teams composed of professors who are bilingual and experts in traffic safety. We used a committee approach to reach a consensus on the translated versions in each phase to avoid the weaknesses of the forward-and-back translation design. We assessed the correctness of the translation by comparing the original and back-translated version. The translated version was then tested on 50 drivers to ensure that the items were clear without any ambiguity. After the testing, the committee made the necessary corrections, changes, and rewording of 9 items of the TCS (item 3, 7, 8, 17, 28, 34, 37, 43 and 44) to resolve any ambiguities based on the feedback from the participants recruited to test the translated version.

Traffic Safety Climate Scale (TSCS)

The TCS, which has been used, included 39 items with three dimensions of safety climate. The items in the dimensions contain statements that depict traffic conditions. These dimensions included: 'External affective Demands' (EAD) which describes the emotional engagement required by road users when participating in traffic (e.g., Aggressive, Exciting, Mobile, Dangerous, etc.) 'Functionalities' (FUN) describes the requirements for a functional traffic system (e.g., Including preventive measures, free flowing, travel easily from place to place, etc.) and 'Internal Requirements' (IRE) focuses on road users' skills and abilities to successfully participate in traffic (e.g., Requiring experience, requiring skilfulness, requiring you to obey traffic rules, etc.). Each item was evaluated by drivers on a 6-point Likert type scale (Does not describe it at all = 1 to Very much describes it = 6). Cronbach's Alpha for internal consistency scores for the EAD (17 items), FUN (12 items) and IRE (10 items) dimensions were 0.94, 0.93 and 0.90 respectively. For more information on how the TCS items were validated, refer to our published article (Chu et al. 2019).

Driver Behaviour Scales

The DBQ and Positive Driver Behaviour scale were adopted from our validated item conducted in China (Chu et al., 2019) to investigate driver behaviours. The DBQ scale included 31 items of Chinese Translated version with three factors of driver behaviours, such as violations (e.g., Cross a junction when traffic lights have already turned on), errors (e.g., fail to notice pedestrians are crossing), and positive driver behaviour (e.g., Avoid close following not to disturb the car driver in front). According to previous studies (Parker et al., 2000), the items in the lapses are not critical for safety, therefore, it was not used in the present study. Each DBQ and positive driver behaviour item was evaluated by the drivers on a 6-point Likert type scale (never = 1, to nearly all the time = 6). Cronbach's Alpha internal consistency scores of the violations (6 items), errors (11 items) and positive driver behaviours (14 items) scales for the present study were 0.81, 0.90, and 0.93, respectively. For more information on how the driver behaviour items were validated, refer to our published article (Chu et al. 2019).

Demographic Variables

Age, sex (male and female), mileage since getting a license (km), and years of driving license were the important demographic variables included in the study. Finally, participants were asked to indicate the number of traffic crashes (all types of crashes drivers experienced) they were involved in over the last 3 years.

Age Grouping

According to World Health Organisation (2018), more than half the people killed in traffic crashes are young adults aged between 15 and 44 years. Based on WHO findings, the drivers between the ages of 18 to 29 were categorised as young, 30 to 44 years was grouped as middle age (young adult) and 45 years and above were clustered as older (adult) drivers.

Statistical Analysis and Procedure

Before the analysis, the distribution of each item was checked for normality. The data was then analysed using descriptive statistics, Pearson's product-moment correlations, and regression analysis. An independent sample t-test was used to examine the significant differences between female and male drivers on the traffic safety climate (TSC) factors, driving behaviours and traffic crash involvement. The correlation analysis was performed to examine the relationship among TSC factors, driving behaviour factors, traffic crash and demographic factors.

Ultimately, Hierarchical Regression Analyses was performed to examine the role of TSC factors in explaining driving behaviours and the probability of traffic crash involvement for female and male drivers. The age group for males and females were further estimated in the Hierarchical Regression Model. The diving behaviour factors and traffic crashes were used as dependent variables in the model and the TSC factors were entered as independent variables. The years of driving license, age and mileage were entered as control variables in the model. All the data were analysed using the SPSS version 24 software.

Results

Independent-sample t-test (comparing Male and Female Drivers)

An independent-sample t-test was conducted to compare the TSC factors, driving behaviour factors and probability of crash involvement for female and male drivers. There were notable differences concerning the violation, traffic crashes and traffic system functionality (Table 2). The results showed that there is a statistically significant difference between females and males on the violations (M = 2.19, SD = 0.79; M = 2.39, SD = 0.86; t (885) = 3.53, p = .000, two-tailed), traffic crash involvement (M = 2.07, SD = 2.00; M = 2.33, SD = 2.17; t (885) = 1.99, p = .023, two-tailed) and traffic system functionality (M = 3.67, SD = 0.96; M = 3.52, SD = 0.97; t (885) = 2.39, p = .017, two-tailed). Despite reaching statistical significance, the magnitude of the differences in the means was quite small (eta squared). Male and female drivers did not differ significantly on error, positive driving behaviour, perceived external affective demand and internal requirements. However, an inspection of the mean scores indicated that

Table 2. Difference between male and female drivers (independent sample t-test)

Constructs	Sex	Number of respondents	Mean	Std. Deviation	T-Value	P-Value
Error	Female	356	1.94	0.69	0.25	0.807
	Male	531	1.93	0.67		
Violation	Female	356	2.19	0.79	3.53	0.000
	Male	531	2.39	0.86		
Positive driving behaviour	Female	356	4.64	0.88	1.08	0.278
	Male	531	4.58	0.89		
Traffic crash involvement	Female	356	1.07	1.00	1.99	0.023
	Male	531	1.33	1.17		
External affective demand	Female	356	3.44	0.86	1.54	0.124
	Male	531	3.53	0.88		
Functionality	Female	356	3.67	0.96	2.39	0.017
	Male	531	3.52	0.97		
Internal requirements	Female	356	4.66	0.81	0.73	0.468
	Male	531	4.62	0.78		

males reported slightly higher levels of the violation and traffic crash involvement than females. On the other hand, the mean score of female drivers was slightly higher than male drivers on the functionality factor.

Correlations

Table 3 shows the results of the correlations between background variables, driving behaviour factors, TSC and traffic crash involvement for female and male drivers. The demographic factors of females had no association with traffic climate factors. Aberrant driving behaviours (errors and violations) were negatively related to functionality and internal requirements. Besides, the positive driving behaviour was positively related to perceived traffic system functionality and internal requirements, but not related to perceived external affective demand.

On the other hand, age and driving license of male drivers had a negative association with functionality with mileage having insignificant relation to TCS factors. Violations, errors and traffic crash involvement had a positive correlation with perceived external affective demand but negatively correlated with perceived traffic system functionality. Positive driving behaviour of male drivers was positively related to traffic system functionality and internal requirements but has no association with the external affective demand.

Hierarchical Regression Analyses (Female Drivers)

Hierarchical multiple regression was used to assess the explanatory power of TSC factors (Functionality, External

Table 3. Correlation between TCS factors, demographic factors, traffic crash involvement and driving behaviours

TSC Factors	Female							Male						
	Err	Viol	PB	PTC	Age	Mileage	YDL.	Err	Viol	PB	PTCs	Age	Mileage	YDL
FUN	-0.20***	-0.11*	0.23***	-0.04	-0.07	0.09	0.04	-0.13**	-0.25***	0.17***	-0.03	-0.17***	-0.04	-0.14**
EAD	0.13*	0.06	-0.05	-0.01	0.12*	-0.03	0.02	0.22***	0.31***	-0.06	0.11*	-0.07	-0.04	0.02
IRE	-0.12*	-0.10*	0.34***	0.04	0.03	0.01	-0.01	-0.02	0.08	0.23***	0.04	-0.01	0.02	0.01

Note: *p < 0.05, **p < 0.01, ***p < 0.001.
Err – error, Viol- Violation, PDB-positive driving behaviour, PTCs – probability of traffic crashes, FUN- Functionality, EAD- External Affective Demand, IRE-Internal Requirements, YDL – Years of Driving License

Table 4. Hierarchical regression analysis on female and male driving behaviours and the traffic crash.

Variables	Errors			Violations			Positive behaviours			Probability of traffic crash involvement		
Female Drivers	**R^2**	**F**	**β**	**R^2**	**F**	**β**	**R^2**	**F**	**β**	**R^2**	**F**	**β**
Background Variables	0.04	0.39		0.05	0.04		0.03	0.11		0.05	1.52	
Age			-0.07			-0.03			0.01			-0.08
Mileage			0.04			0.02			0.01			-0.04
Years of driving license			0.08			0.05			0.04			0.03
Main effects	0.12	6.52^{***}		0.07	2.05		0.22	12.84^{***}		0.04	1.01	
Functionalities			-0.05			-0.03			0.01			-0.05
External A. Demands			0.27^{***}			0.15^{*}			-0.31^{***}			-0.02
Internal Requirements			-0.34^{***}			-0.20^{**}			0.46^{***}			0.03
Total R^2	**0.16**			**0.12**			**0.25**			**0.09**		
Male Drivers												
Background Variables	0.05	1.08		0.06	1.03		0.04	0.23		0.08	9.11^{***}	
Age			-0.06			0.03			0.05			-0.08
Mileage			0.04			0.04			-0.01			0.19^{***}
Years of driving license			0.05			0.06			0.02			0.05
Main effects	0.19	11.12^{***}		0.21	18.02^{***}		0.18	11.25^{***}		0.06	4.43^{**}	
Functionalities			-0.04			-0.16^{***}			0.16^{***}			-0.03
External A. Demands			0.36^{***}			0.36^{***}			-0.14^{*}			0.04
Internal Requirements			-0.23^{***}			-0.10^{*}			0.31^{***}			0.04
Total R^2	**0.24**			**0.27**			**0.22**			**0.14**		

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Affective Demand and Internal Requirements) in driving behaviours and the probability of crash involvement, after controlling for the influence of age, mileage and years of driving license. The result in Table 4, demonstrates that the demographic factors were not associated with driving behaviour factors and the probability of crash involvement. Similarly, the TSC factors have no significant association with the probability of traffic crash involvement.

The perceived external affective demand positively related to driving errors (β =0.27; p< 0.001) and violations (β =0.15; p< 0.05) but negatively related to positive driving behaviour (β = -0.31; p< 0.001). However, perceived internal requirement was negatively related to errors (β = -0.31; p< 0.001) and violations (β = -0.31; p< 0.001), but positively related to positive driving behaviour (β = -0.31; p< 0.001). Perceived functional traffic systems had no significant relation with driving behaviour factors and traffic crash likelihood. The variance explained in the driving behaviour factors and probability of traffic crash involvement are also indicated in Table 4.

Hierarchical Regression Analyses (Male Drivers)

The result in Table 4 further indicates that control variables (age and years of driving license) were not related to driving behaviour factors and crash involvements. However, mileage was related to the likelihood of traffic crash involvements (β =0.19; p< 0.001), but not driving behaviours.

The perceived external affective demand was positively related to driving errors (β =0.36; p< 0.001) and violations (β =0.36; p< 0.05) but negatively associated with positive driving behaviour (β = -0.14; p< 0.05) whereas perceived

Table 5. Effect of TSC on driving behaviours and traffic crash for the age groups (females and males)

TSC Factors/ Age groups	Females								Males							
	Err		Viol		PB		PTC		Err		Viol		PB		PTC	
	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β
Young (18-29)	0.23		0.10		0.30		0.16		0.29		0.23		0.26		0.17	
FUN		-0.04		-0.02		0.05		-0.09		-0.02		-0.13*		0.17*		-0.07
EAD		0.32***		0.20*		-0.21*		-0.01		0.45***		0.40***		-0.25**		0.05
IRE		-0.30**		-0.12*		0.46***		-0.33***		-0.26**		-0.14*		0.36***		0.10
Middle age (30-44)	0.19		0.11		0.26		0.11		0.18		0.20		0.20		0.12	
FUN		-0.05		-0.02		0.02		-0.06		0.01		-0.16*		0.08		-0.06
EAD		0.21**		0.14*		-0.35***		-0.09		0.32***		0.29***		-0.11*		0.12*
IRE		-0.31***		-0.21**		0.41***		-0.01		-0.18**		-0.05		0.32***		0.01
Older (45+)	0.26		0.24		0.27		0.27		0.20		0.33		0.19		0.14	
FUN		-0.35***		-0.23**		-0.08		-0.14*		-0.19*		-0.22**		0.18*		-0.15*
EAD		-0.30**		- 0.36***		-0.21**		-0.36***		0.13*		0.29**		0.06		-0.03
IRE		0.02		0.02		0.35***		-0.25***		-0.18*		-0.03		0.16*		-0.01

Note: *p < 0.05, ** p < 0.01, ***p < 0.001.

Err -error, Viol- Violation, PB-positive behaviour, PTC- Probability of Traffic crash, FUN- Functionality, EAD- External Affective Demand, IRE-Internal Requirement.

Years of driving license and mileage were used as control variables in the model.

R^2 – Variance explained in dependent variable, β - Standardised Coefficients.

internal requirement was negatively related to errors (β = -0.23; p< 0.001) and violations (β = - 0.10; p< 0.05) but positively related to positive driving behaviour (β =0.31; p< 0.001). The TSC factors have no significant association with probability of traffic crash involvement. It must be noted, however, that, the variance explained in aberrant driving behaviours and the probability of crash involvements by male drivers' model was higher than their female counterparts. However, the variance explained in the positive driving behaviour is high for female drivers compared to males (see Table 4).

Age Grouping for Female and Male Drivers

The result in Table 5 illustrates that perceived external affective (EAD) demand was positively related to aberrant driving behaviours but negatively related to positive driving behaviour for both young and middle-aged female drivers. On the other hand, the perceived internal requirement (IRE) was negatively related to aberrant driving behaviours but positively related to positive driving behaviour. Again, IRE had a negative relation with the probability of traffic crash involvement for the young and older female drivers. Moreover, the result further showed that, for older female drivers, the perceived traffic system functionality and EAD were negatively related to driving behaviour factors. In addition, the functionality and EAD were negatively associated with probability of traffic crash involvement.

Similar to the findings of female drivers, the result in Table 5 demonstrates that for both young and middle-aged male drivers, the perceived EAD had a positive relation with aberrant driving behaviours, but was negatively related to positive driving behaviour. More so, the result shows that EAD factor was positively related to probability of traffic crash involvement (β = 0.12; p< 0.05) for middle-aged drivers. On the other hand, the perceived IRE was negatively associated with aberrant driving behaviours but positively related to positive driving behaviour for young and middle-aged drivers. The result further revealed that for older male drivers, the perceived traffic system functionality was negatively related to aberrant driving behaviours and probability of traffic crash involvement. Besides, functionality was positively associated with positive driving behaviour. The perceived EAD was positively related to errors and violations but has no significant association with positive driving behaviour and

traffic crash involvement. Perceived IRE had a significant negative relation with errors, but positively related to positive driving behaviour with no significant association with traffic crash involvement for older drivers.

Discussion

The study aims to examine the explanatory power of Traffic Safety Climate factors (i.e., external affective demand, functionality and internal requirements) in driving behaviours and probability of traffic crash involvement among male and female drivers in China, taking into consideration different age groups.

The result showed that male and female drivers express driving violations and probability of traffic crashes differently, with males reporting high driving violations, emotional engagement and traffic crashes than female drivers. In accordance with a previous study, this result implies that traffic crashes among male drivers happened more as a consequence of traffic rule violations (Parker et al., 1995) and perception that traffic is emotionally demanding (Chu et al. 2019).

The differences in TSC and driver's behaviour factors revealed that there was no significant difference in errors, positive driving behaviour and perceived external affective demand and internal requirements for both sexes. This suggests that males and females held similar perceptions concerning the frequency of committing driving errors and positive driving behaviour as well as emotional engagement and vehicle handling skills in traffic. However, in accordance with a previous study, it appears that females reported more driving errors than male drivers (De Winter et al 2010). Similarly, female drivers demonstrated high positive driving behaviours and perception of vehicle handling skills in traffic compared to male drivers. Most likely, females exhibit more positive driving behaviour because traffic situations that require vehicle handling skills may have forced them to alter driving behaviours.

The correlation analysis revealed that, except for age that had a negative correlation with functional traffic systems for male drivers, mileage and probability of traffic crash involvement show no association with traffic safety climate factors for both male and female drivers. This result means that age is an important factor to be considered in the study that seeks to promote traffic safety. As expected, the perceived functional traffic system and the internal requirement was negatively related to aberrant driving behaviours and positively related to positive driving behaviour for both male and female drivers. This finding is in line with a previous study (Gehlert et al., 2014), revealing that perceived internal requirements and traffic system functionality are related to road safety behaviours. In addition, other researchers have indicated that positive driving behaviour has the capability to reduce aberrant driving behaviours (Özkan & Lajunen, 2005a). The result suggests that functional traffic systems together with the appropriate driving skills in traffic lead to higher positive driving behaviours and less aberrant driving behaviours (Özkan & Lajunen, 2005; Chu et al 2019) among male and female drivers. These measures could help individual drivers to interact effectively with different traffic conditions in order to achieve the desired road safety in China. Nonetheless, the result has further demonstrated that male drivers aberrant driving behaviours could be partly linked to the conditions in physical traffic environments (external affective demand). The possible explanation for this result could be that, when male drivers perceived traffic to be more emotionally demanding, they tend to violate the acceptable driving rules whereas females do not (e.g., Harrison, 2009). Female drivers are to some extent safer drivers in traffic than male drivers in China (Wei, Chen & Wang, 2015). In support of the previous studies, we can therefore claim that traffic system functionality is the most important factor of traffic safety climate tool for explaining observed differences in demographic factors in traffic (Ward et al., 2010).

TSC Factors in explaining DB and Traffic crashes for Male and Female

In the comparative analysis, it was clear that none of the perceived traffic safety climate factors had a significant association with traffic crash involvements. In line with the previous studies, this indicates that, although an accident is most often an outcome of risky driving behaviours, not all traffic conditions could result in an accident (Özkan & Lajunen, 2005b). The reasons a driver may engage in particular driving behaviour is dependent on the perceived traffic conditions. On the other hand, a previous study has revealed that TSC is related to accident involvement in an indirect way through proximal factors such as driving behaviours (Chu et al, 2019). In the present study, we explored the direct association between TSC factors and traffic crash involvement. It is possible that TSC factors may be related to traffic crash involvement only when mediated by driving behaviour factors. However, further studies are needed to explore how TSC factors are related to traffic crash involvement for drivers in China.

According to the results, the variance explained in aberrant behaviours variables were higher for male drivers compared to the female drivers whereas the variance explained in positive driving behaviour was higher for female drivers than the male drivers. In accordance with previous findings, it is evident that male drivers overestimate their driving skills and emphasise vehicle handling skills rather than safety (Özkan & Lajunen, 2005b; Wei, Chen & Wang, 2015) whereas female drivers are more concerned about safety in traffic. This finding emphasises the fact that when developing measures to reduce risky driving behaviours and enhance traffic safety, both male and female drivers have to be taken into consideration. However, male drivers are of a major concern than female drivers.

Differences among Age Groups for Male and Female Drivers

Though the difference between female and male drivers has been established, it could not be established which age (young, middle-aged and older drivers) among these groups are of more concern. Therefore, the characteristics of different ages for males and females were presented. The result demonstrated that perceived external affective demand was positively related to aberrant driving behaviours and negatively related to positive driving behaviour for young and middle aged for both male and female drivers. This result suggests that when the young and middle-aged groups for both male and female drivers perceive traffic systems to be emotionally demanding (e.g., "aggressive," "putting pressure," and "dangerous"), their positive behaviour decreases and tend to commit errors and traffic rules violations. In accordance with a previous study, the result further, explains that regardless of sex characteristics young and middle-aged driver's tendency to involve in risky driving behaviour or underestimate hazards in traffic is related to the situations or conditions in the traffic (Alfonsi et al. 2018). Within the bracket of older drivers, females were less likely than male drivers to engage in perilous driving behaviour and report a high probability of traffic crashes. In general, the results imply that irrespective of age, male drivers as a group are more likely to experience high traffic crashes as per the perception that traffic is emotionally demanding.

The result further evidenced that perceived internal requirement is more likely to enhance positive driving behaviours but prevent aberrant driving behaviours of young and middle-aged drivers of both sexes. Likewise, the perceived internal requirement enhances both male and female older drivers' positive behaviour. This demonstrates that when both sexes perceive traffic conditions to require driving skills/capabilities such as experience, cautious, and vigilance, they tend to promote positive driving behaviour and avoid committing errors as well as violations of driving norms (Chu et al. 2019; Gehlert et al. 2014). Conversely, perceived required driving skills is more likely to increase young female drivers' crash rate than males. This means that female young drivers have defects in their driving skills when the traffic environment is complex and are likely to experience crashes. Consistent with this finding, Drummond and Yeo (1992), also reported that females have a higher causality involvement rate compared to males. However, satisfactory driving skills in traffic is less likely to affect female older drivers' crash rate than that of male drivers. This explains that, when female drivers are young, they are likely to experience more traffic crashes and as they grow old, the rate of traffic crash is likely to decrease.

Further, the result established that perceived functional traffic systems which include; "Planned," preventive measures," "dependent on mutual consideration,", is indisputably associated with violations, but negatively associated with positive behaviour (Chu et al., 2019) of male young and middle-aged drivers. Within the bracket of the older drivers, the perceived traffic system functionality was not associated with aberrant driving behaviour of both sexes, but related to the positive driving behaviour of male older drivers, but not for female drivers. These results imply that drivers can avoid aberrant driving behaviours when the traffic situations meet their physical driving abilities. Besides, when traffic systems are functional it is likely to promote positive driving behaviour of older male drivers but may not motivate female drivers to exhibit positive driving behaviour in traffic. The result further demonstrated that a functional traffic system is likely to be a tool for plummeting traffic crash involvement for both male and female drivers.

In summary, the study suggests that the traffic safety climate factors have an appreciated relationship with driving behaviours and traffic crash involvement among male and female drivers in China. Emotional engagement in traffic is linked to aberrant driving behaviours and traffic crash involvement especially, among male drivers. However, a perceived functional traffic system together with perceived internal requirements such as vehicle handling skills/capabilities in traffic is positively related to positive driving behaviours but negatively related to aberrant driving behaviours as well as traffic crash involvement in China.

Practical Implications

The traffic condition has a considerable significant association with driving behaviours and traffic crashes in China. Moreover, this problem seems to be growing due to aberrant driving behaviours among drivers. The results of the study consistently indicate that, with functional traffic systems together with appreciable vehicle handling skills, drivers can effectively participate in traffic and can circumvent aberrant driving behaviours and exhibit positive driving behaviours. Therefore, traffic authorities should give special attention to the modification of traffic infrastructure systems designed to facilitate effective interactions and reduce risky driving behaviours in traffic. In addition, there is the need to conduct regular traffic safety exercise tailored towards developing drivers especially, young males driving skills and positive driving behaviour that will limit emotional engagement and crash involvement.

It is also obvious that the basic requirements such as enforcement and education of safe traffic have to be directed towards male drivers, especially young and middle-aged drivers in order to promote positive driving behaviour and reduce aberrant behaviours in China.

When traffic is perceived to be emotionally demanding, young male drivers are likely to incur the majority of crashes and this is likely to remain unchanged in the

future. The high traffic crash involvement reflects the deficiency of vehicle handling skills that do not meet different traffic conditions. Therefore, it is imperative to identify specific assertiveness associated with young male drivers' risky driving behaviours and discourage such inappropriate behaviour by increasing the booking fine for road traffic offenders. This intervention will promote positive driving behaviours that will limit emotional engagement and optimise driving skills in terms of crash avoidance.

One of the strategies that have been proven to be effective in reducing risk-taking behaviour is the participatory approach (Mason et al., 2013). This will mean engaging the young and middle-aged drivers in empowering ways to define their driving behaviours and crash rates in different traffic conditions and to develop solutions to the challenges they face in traffic. This approach will allow these categories of drivers to find out themselves the need for behavioural change and how the change process should take place.

Conclusion

Studies have concluded that sex and age of a driver have an independent effect on driving behaviour and driving safety (Parker et al. 1992; Shinar, 2017). The evidence from multiple studies has revealed that sex and age are more important to be considered in a study that attempts to promote driving safety (McCartt et al., 2009; Shinar, 2017). However, in the field of traffic safety study, there is little finding on the impact of traffic safety climate factors on drivers' behaviour and traffic crashes, particularly among male and female drivers hence, the need for this study.

The result demonstrates that male and female drivers in China expressed different perceptions about traffic safety, driving behaviours, and traffic crashes. However, in some instances, there is no significant difference between male and female drivers. Male drivers have a higher emotional engagement, driving violations and crash rates than female drivers. Whereas female drivers exhibited more internal requirements, positive behaviours and driving errors. The decrease in the traffic crash involvement according to age is larger among male than female drivers. The aberrant driving behaviour and traffic crash become regular when traffic is perceived to be emotionally demanding with young and middle-aged drivers experiencing the majority of crashes. Perceived internal requirements and traffic system functionality, on the other hand, promote positive driving behaviour, but reduce aberrant driving behaviours of both sexes with a low traffic crash involvement. In support of previous study, it is, therefore, imperative that the traffic authorities give special attention to the modification of traffic infrastructure designs (Regmi, 2021) to optimise vehicle handle skills which are likely to promote positive driving behaviours and limit emotional engagement as well as aberrant driving behaviours in traffic. It should be noted, however, that, the difference in road traffic injuries and fatalities, as well as driver behaviours among countries, might be influenced by the perceived traffic climate of a country traffic context (Yeşim Üzümcüoğlu Zihni, 2018). Therefore, ways of expressing behaviours in traffic can be expected to vary from country to country.

Limitations

The results may have limitations related to self-reported data. Although participants were assured of anonymity and confidentiality, their responses may have been biased towards social desirability. Drivers may underreport their view about traffic conditions, driving behaviours and traffic crash involvement. A purposeful underreporting is not a problem as long as that underreporting is true for all groups under study and the focus of interest is not on the absolute but the difference between driver groups (Laapotti 2001). Lajunen and Summala (2003), also concluded that social desirability has a relatively small impact on traffic safety studies. Notwithstanding the limitations, the study has some implications for safety research and traffic safety campaigns in China. The study concludes with a suggestion that there is the need to conduct traffic safety exercise that is tailored towards developing young males driving skills and positive driving behaviour that will limit emotional engagement and crash involvement.

The study focused only on age in the aberrant driving behaviours and traffic crash involvement. However other demographic variables such as educational level, marital status, occupation/income level, among others may influence driving behaviours and traffic crashes. Therefore, further research on these variables is recommended. In addition, the present study explored the direct association between TSC factors and driving behaviours as well as traffic crash involvement. It is possible that driving behaviour variables will mediate the relationship between TSC factors and traffic crash involvement. Therefore, further study can be conducted to test the mediational role of driving behaviours in the relationship between TSC and traffic crash involvement using the Structural Equation Model.

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