



Full length article

Effect of personality traits, age and sex on aggressive driving: Psychometric adaptation of the Driver Aggression Indicators Scale in China

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ABSTRACT

This study aimed to assess the reliability and validity of the Chinese version of the Driver Aggression Indicators Scale (DAIS), which measures aggressive driving behaviors. Besides, demographic variables (sex and age) and the big five personality traits were examined as potential impact factors of aggressive driving. A total of 422 participants completed the DAIS, Big Five Personality Inventory (BFPI), and the socio-demographic scale. First, psychometric results confirmed that the DAIS had a stable two-factor structure and acceptable internal consistency. Then, agreeableness and conscientiousness were negatively correlated with hostile aggression and revenge committed by the drivers themselves, while neuroticism was positively correlated with aggressive driving committed by the drivers themselves. Meanwhile, more agreeable drivers may perceive less hostile aggression and revenge. More neurotic drivers may perceive more aggressive warning. Finally, the effects of age and sex on aggressive driving were not same as most studies. We found that older age group perceived and committed more hostile acts of aggression and revenge than younger age groups. Female drivers of 49–60 years perceived more aggressive warnings committed by other drivers.

1. Introduction

Aggressive driving is a significant factor causing traffic crashes (Paleti et al., 2010). An American study found that 55.7% of 106,727 fatal crashes between 2003 and 2007 involved potentially aggressive driving behaviors (AAA Foundation for Traffic Safety, 2009). A cross-culture study of four countries showed that aggressive driving behaviors were significantly correlated with more traffic accidents (Özkan et al., 2010).

Although aggressive driving has been studied for several decades, its definition lacks cohesion and specificity. This has been pointed out in several recent studies (Conner and Smith, 2014; Nesbit and Conger, 2012; Perepjolkina and Reñge, 2013; Suhr, 2016; Suhr and Nesbit, 2013). Some researchers focused on observational behaviors, and defined aggressive driving as “any unsafe driving disregard for other road users’ safety by placing them in unnecessary danger” (Harris et al., 2014; Houston et al., 2003). Some researchers focused on the intentions behind the behavior, defined aggressive driving as “any form of driving behavior that is intended to injure or harm other road users physically or psychologically” (Burtaverde et al., 2016; Kováčsová et al., 2014; Kováčsová et al., 2016; Lajunen et al., 1998). Moreover, researchers suggested that both driving behaviors that disregard other road users’

safety and intend to harm others were aggressive driving (AAA Foundation for Traffic Safety, 2009; Goodwin et al., 2013). In this study, we use the second definition that considers intention as a primary factor. On the one hand, it is in accord with the general definition of aggressive behavior – “any behavior directed toward another individual that is carried out with the proximate (immediate) intent to cause harm” (Baron and Richardson, 1994; Anderson and Bushman, 2002); on the other hand, it is easier to distinguish aggressive driving from other unsafe driving such as violations and risky driving. In this definition of aggressive driving, intention matters; for example, when drivers speed up to overtake, trying to irritate other drivers or gain psychological advantage, this constitute aggressive driving behavior.

Aggressive driving includes extreme aggressive reactions of “road rage”, e.g., car ramming or physical attacks, as well as more moderate aggressive road behaviors, e.g., gestures of disapproval, blocking other drivers, and cutting off other cars (Özkan et al., 2010). The initial authors of the DAIS – Lajunen and Parker found that the aggressive violation subscale of the Driver Behavior Questionnaire (DBQ; Reason et al., 1990; Lawton et al., 1997; Lajunen et al., 2004) didn’t cover all aggressive driving behaviors. Therefore, they developed the DAIS to measure aggressive driving behaviors comprehensively and exclusively

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(Özkan and Lajunen, 2005; Özkan et al., 2011). The DAIS consists of 13 items reflecting drivers' possible aggressive behaviors on the road in daily life. It has been validated in Finland, Great Britain, The Netherlands, Turkey (Özkan et al., 2010) and Slovakia (Kováčová et al., 2014). Studies indicated that the DAIS has a clear factor structure, high item loading, and acceptable internal consistency across different countries. Comparing to the Dula Dangerous Driving Index (DDDI; Dula and Ballard, 2003), which also measures aggressive driving, we found that the seven items in aggressive driving subscale of DDDI were included in the DAIS. Furthermore, the structure of aggressive driving could be explored through the DAIS, while aggressive driving was only a dimension of DDDI. Therefore, it is necessary to develop a Chinese version of the DAIS.

General Aggression Model (GAM) was established for better understanding of how aggressive behaviors are committed (Anderson and Bushman, 2002). This model has been used in studies of aggressive driving (Kováčová et al., 2016; Suhr, 2016). GAM consists of 1) person and situation inputs (i.e., person factors like demographic variables and traits, or situational factors like aggressive cues and provocations); 2) internal affective and cognitive processes; 3) outcomes of appraisal and decision processes. Person and situation inputs can lead to aggressive cognitions and behaviors via specific internal state activation (Anderson and Bushman, 2002; Chester et al., 2014). This study focused on the effects of person inputs (age and sex as demographic variables, and personality traits as individual difference) on aggressive driving. The impacts of these factors on driving should not be ignored; a Norwegian study showed that personality traits and sex explain 37.3% of the variation in risky driving behaviors (Olteidal and Rundmo, 2006). In addition, drivers constantly interact with other drivers, so cognition of other drivers' behaviors matters (Åberg et al., 1997; Möller and Hausteijn, 2014; Stewart, 2005). Therefore, the participants were asked to rate twice when filling the DAIS, once for aggressive driving behaviors they committed themselves and once for how often they perceived other drivers' aggressive driving behaviors.

Personality traits reveal individuals' particular patterns of behavior in a variety of situations. Stable personality traits may predispose individuals to experience different mood states, in turn influencing their emotional arousal and behavioral responses (Rusting, 1998). One of the most widely used constructs of personality is the Big Five Factor Model (John et al., 1991). According to previous studies, aggressive driving behaviors were associated with lower scores of agreeableness (Aniței et al., 2014; Cellar et al., 2000; Dahlen et al., 2012), conscientiousness (Aniței et al., 2014; Dahlen et al., 2012; Harris et al., 2014) and openness (Harris et al., 2014; Vazquez, 2013), and with higher scores of neuroticism (Jovanović et al., 2011; Sârbescu et al., 2014) and extroversion (Burtaverde et al., 2016; Harris et al., 2014).

Sex and age are two demographic variables that influence driving behaviors. Drivers of different age and sex may exhibit distinct driving abilities and risk preferences. The sex effect on aggressive driving was inconsistent among studies. Most studies found that males reported more aggressive driving behaviors than females (Dahlen and White, 2006; Perepjolkina and Reñge, 2013; Sârbescu et al., 2014). Others reported that sex was not a significant factor influencing aggressive driving (Jovanović et al., 2011; Vazquez, 2013; Wickens et al., 2012). And we found only one study showing that females were involved in more aggressive driving (Harris et al., 2014). The inconsistency might be related to differences in the intensity of aggressive driving. A study of 192 students demonstrated that male and female drivers reported similar levels of mild aggressive driving, while males reported more violent driving out of vengeful attitude (Hennessy and Wiesenthal, 2002). As for age difference, previous studies showed that age was negatively correlated with aggressive driving (Dahlen and White, 2006; Krahé, 2005; Krahé and Fenske, 2001; Perepjolkina and Reñge, 2013; Wickens et al., 2011). Young male drivers are considered a high-risk group, committing more aggressive behaviors and involved in a higher number of traffic accidents (Perepjolkina and Reñge, 2013; Vanlaar

et al., 2008).

In summary, aggressive driving related study is important for the prevention of traffic accidents, and this unsafe driving attracts increasing attention. However, useful tools measuring aggressive driving is needed in China, so we validated the DAIS. Finally, the associations of aggressive driving with age, sex and personality traits offer a quick detection of aggressive drivers, which could be inspiring for later researches. The study goals are listed below:

- (1) to develop a Chinese version of the Driving Aggressive Indicator Scale (DAIS);
- (2) to assess the relationship between personality traits and aggressive driving;
- (3) to analyze the effects of age and sex on aggressive driving behaviors.

2. Methods

2.1. Participants and procedure

We selected specific locations such as parking lots and residential areas to recruit participants in Beijing, China. Participants were assured of anonymity and confidentiality. The data were collected by a professional research company. Initially, 448 drivers participated in this investigation. After excluding 26 non-serious participants, 422 subjects in total were assessed. Participants were asked to provide their age, sex, education, number of years after acquisition of full driving license, total/annual number of kilometers driven, and number of accidents during the last 3 years. Accidents during last 3 years were measured using the question "In the last three years of driving experience, how many times did you collide with another vehicle, pedestrian, stationary obstruction et al., including mild vehicle damage to severe casualties, whether you were the primary responsible or not." There were 67.8% (286) male and 32.2% (136) female participants. As shown in Table 1, the distribution of age and driving experience in male and female participants were balanced, demonstrating a good representativeness of our sample.

2.2. Measures

2.2.1. the driver aggression indicator scale (DAIS)

The DAIS was developed to assess aggressive driving behaviors exclusively (Özkan and Lajunen, 2005). It consists of 13 items, reflecting possible aggressive driving behaviors on the road in daily life. Participants rated the scale twice, once for "self", reflecting the frequency of such behaviors committed by drivers themselves, and once for "others", reflecting the frequency of their perception of other drivers' aggressive behaviors. The answers ranged from 0 ("never") to 4 ("nearly all the time"). The DAIS has been validated in four different countries, including Finland, Great Britain, the Netherlands, and Turkey (Özkan et al., 2010). It consistently showed a clear two-factor solution for the two parts (both "self" and "other" parts). The first factor was termed "aggressive warning" (AW), with the items reflecting mostly aggressive warnings on the road such as "sounding horn". The second factor was termed "hostile aggression and revenge" (HAR), to describe a driver's hostile actions such as "physical attack". Further, internal consistency coefficients were acceptable. For the *self* part, alpha reliability values for HAR and AW were 0.89 and 0.84, respectively. In the *other* part, alpha reliability values were 0.86 and 0.75, respectively (Özkan and Lajunen, 2005). This scale was translated into Chinese from the English version, by at least two psychologists to ensure that participants understood the meaning of each item clearly.

2.2.2. The big five personality inventory (BFPI)

The BFPI consists of five personality factors, which encompass a total of 44 items (John et al., 1991). These five factors are: extroversion

Table 1
Participant demographics (N = 422).

	N	Percent
Age groups by sex		
20–30		
male	55	13.0%
female	25	5.9%
31–40		
male	84	19.9%
female	41	9.7%
41–50		
male	92	21.8%
female	41	9.7%
51–60		
male	55	13.0%
female	29	6.9%
Education		
high school or below	69	16.4%
college degree	128	30.3%
bachelor degree or above	225	53.3%
Driving experience (year)		
1–4 years	80	
5–8 years	125	
> 8 years	133	
Total mileage (km)		
≤ 20000	90	21.3%
20001–50000	120	28.5%
50001–100000	115	27.2%
≥ 100001	97	23.0%
Annual mileage (km)		
200–6000	109	25.8%
6001–9000	111	26.3%
9001–14000	132	31.3%
≥ 14000	70	16.6%
Accidents		
0	235	55.7%
1–2	121	28.7%
≥ 3	66	15.6%

(8 items, e.g., “I see myself as someone who is talkative”), agreeableness (9 items, e.g., “I see myself as someone who likes to cooperate with others”), conscientiousness (9 items, e.g., “I see myself as someone who does a thorough job”), neuroticism (8 items, e.g., “I see myself as someone who can be moody”), and openness to experience (10 items, e.g., “I see myself as someone who is inventive”). Each item was evaluated on a 5-point Likert scale, ranging from “Strongly Disagree” to “Strongly Agree”. The BFPI showed satisfactory reliability and validity. The Cronbach’s alpha values of the five factors were above 0.79, with a mean of 0.83; meanwhile, a convergent study revealed good validity (John and Srivastava, 1999).

3. Results

3.1. Descriptive analysis of each item and factor structure of the chinese version of DAIS

Mean values and standard deviations (SD) of each item of the “self” and “others” parts were presented, respectively (see Table 2). Apparently, most mean values of the items were below 1, except items 1, 2, 8 and 12 (the mean value of item 2 was 0.99, and almost 1 in the “others” part). The DAIS was rated twice by each subject. First they were asked to rate the frequency they committed the behaviors in each item (“self” part); then, the subjects were asked to rate how often they perceived other drivers’ committed these behaviors (“others” part). So, principle component analysis (PCA) was run twice, for “self” and “others” parts, separately. The KMO values were 0.94 and 0.92, respectively, which indicated appropriateness for PCA. The 13 items were subjected to principal axis factoring analysis, with direct oblimin rotation. Both self

and others parts showed a two-factor structure with eigenvalues above 1.0. The final results are displayed in Table 4. Further, factors loadings from the initial analyses below 0.30 were omitted, and the item loaded on both factors was removed. For the self part, items 12, 1, and 8 were loaded on aggressive warning (self_AW), and the remaining on hostile aggression and revenge (self_HAR) except item 2, accounting for a total variance of 65.87%. The Cronbach’s alpha values of self_AW and self_HAR were 0.62 and 0.95, respectively. For others part, the factor structure was almost similar to that of the “self” part, and only item 2 was loaded on HAR. We used the abbreviation other_AW to denote aggressive warnings of others, with other_HAR representing hostile acts of aggression and revenge by others. A total variance of 64.38% was explained. The Cronbach’s alpha values of other_AW and other_HAR were 0.67 and 0.94, respectively. Furthermore, when the scales were used together, the alpha values were 0.93 and 0.92 for the self and others parts, respectively.

3.2. Correlation and regression analyses

As shown in Table 3, age was positively correlated with HAR in both self and others. AW and HAR for both self and others were positively correlated with neuroticism, and negatively with extroversion, agreeableness, conscientiousness, and openness. However, no significant correlation was found between DAIS and accident count during the last three years.

Hierarchical regression analyses were conducted for HAR and AW, respectively, by oneself and other drivers (see Table 4). In the first step, sex, age, and driving years were entered as control variables; in the second step, the five personality traits were entered. The results showed that neuroticism was a significant predictor of self_AW and other_AW. Agreeableness was a significant predictor of self_HAR and other_HAR. Meanwhile, conscientiousness was a significant predictor of self_HAR.

3.3. Multivariate analysis of variance (MANOVA) tests: effects of age and sex on DAIS

Since age and sex are important characteristics identifying aggressive drivers, we divided the patients into the following 4 age groups: 20–32 years (27.60 ± 3.39), 33–41 years (36.82 ± 2.69), 42–48 years (44.06 ± 1.72), and 49–60 years (53.72 ± 3.28). The descriptive statistics are shown in Tables 5A and 5B.

The MANOVA results are displayed in Table 6. Age had a significant effect on HAR of both self and others. As illustrated in Figs. 1 and 2, post hoc *t*-tests confirmed that older groups (42–48 and 49–60 years) exhibited increased self_HAR and other_HAR compared with the individuals aged 20–32 years. In addition, the interaction effect between age and sex was significant on other_AW. As shown in Fig. 3, different age groups of male participants showed no difference, while females aged 49–60 years reported more other_AW than women aged 42–48 years and 20–32 years ($F(3) = 3.93$, $p < 0.01$). In terms of sex differences among the different age groups, female participants only in the 49–60-year age group reported higher other_AW compared with male participants ($F(1) = 8.30$, $p < 0.01$).

4. Discussion

4.1. Summary of findings

This was the first study translating the DAIS into Chinese to measure aggressive behaviors in Chinese drivers. A good reliability of this scale was found. As for associations of the big five personality traits with aggressive driving, more agreeable and conscientious drivers reported less HAR; more neurotic ones committed increased AW. In addition, agreeableness was correlated with less perceived other_HAR behaviors. Neuroticism was associated with increased perceived other_AW. Finally, the older age group perceived and committed more HAR acts

Table 2
Principle component analysis of DAIS (self and other parts).

	Self			Other		
	HAR	AW	Mean (SD)	HAR	AW	Mean(SD)
10. Hugged the rear bumper	0.90		0.48(0.84)	0.86		0.52(0.90)
4. Threatened verbally	0.90		0.64(0.98)	0.82		0.68(0.92)
5. Made a hand gesture	0.90		0.56(0.92)	0.89		0.68(0.93)
9. Threatened physically	0.88		0.52(0.90)	0.87		0.59(0.91)
6. Physically attacked	0.85		0.49(0.85)	0.88		0.57(0.93)
11. Prevented or obstructed from manoeuvring the vehicle	0.81		0.62(0.90)	0.64		0.82(1.01)
3. Rammed a vehicle	0.80		0.59(0.90)	0.81		0.54(0.81)
7. Drove slowly in order to annoy the driver behind	0.73		0.67(0.98)	0.60		0.87(0.99)
13. Chased	0.66		0.69(0.99)	0.66		0.81(1.04)
12. Sounded horn		0.80	1.47(1.06)		0.82	1.60(1.09)
1. Cut up		0.71	1.25(0.83)		0.56	1.62(0.82)
8. Flashed lights		0.64	1.13(1.03)		0.86	1.50(0.98)
2. Swore/verbally abused	–	–	1.17(0.98)	0.71		0.99(0.90)
Cronbach's alpha values	0.95	0.62		0.94	0.67	
Variance (%)	57.59%	8.28%		52.58%	11.80%	

Note: “–” indicates double loading and dropped item; the Cronbach's alpha values were calculated after removing the items. “AW”, “aggressive warning”; “HAR”, “hostile aggression and revenge”.

Table 3
Correlations among sex, age, DAIS scales and personality traits.

	1	2	3	4	5	6	7	8	9	10	11	12	13	13
1. Sex	1													
2. Age	0.01	1												
3. Education	0.15**	–0.23*	1											
4. Driving years	–0.04	0.37**	–0.17**	1										
5. Annual mileage	–0.07	–0.11*	–0.05	0.17**	1									
6. Self_AW	0.06	0.07	–0.11*	0.07	0.08	1								
7. Self_HAR	–0.01	0.16**	–0.14**	0.14**	–0.04	0.59**	1							
8. Other_AW	0.03	0.03	–0.07	0.03	–0.01	0.41**	0.31**	1						
9. Other_HAR	0.00	0.14**	–0.10*	0.13**	–0.06	0.52**	0.84**	0.44**	1					
10. Extroversion	0.15**	–0.22**	0.08	–0.11*	0.07	–0.10*	–0.25**	–0.07	–0.24**	1				
11. Agreeableness	0.09*	–0.23**	0.12*	–0.12*	–0.07	–0.21**	–0.40**	–0.07	–0.42**	0.44**	1			
12. Conscientiousness	0.13**	–0.21**	0.07	–0.14*	–0.04	–0.18**	–0.37**	–0.03	–0.38**	0.53**	0.69**	1		
13. Neuroticism	–0.10*	0.20*	–0.10*	0.13*	–0.05	0.22**	0.32**	0.15**	0.36**	–0.50**	–0.62**	–0.68**	1	
14. Openness	0.08*	–0.14**	0.14**	–0.11*	–0.05	–0.11*	–0.22**	0.01	–0.19**	0.56**	0.50**	0.47**	–0.39**	1
15. Accidents of last 3 years	–0.01	–0.06	0.11*	0.06	0.06	–0.03	–0.09	–0.01	–0.04	0.11*	0.02	0.02	–0.08	0.02

Note: “HAR”, hostile aggression and revenge; “AW”, aggressive warning.

Table 4
Hierarchical regression analyses of HAR and AW.

	Self_AW		Self_HAR		Other_AW		Other_HAR	
	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
Sex	0.06	0.08	0.00	0.05	0.03	0.04	0.00	0.06
Age	0.05	0.00	0.13*	0.03	0.02	–0.01	0.11*	0.01
Driving years	0.06	0.04	0.09	0.07	0.02	0.02	0.09	0.07
Extroversion		0.03		–0.06		–0.07		–0.05
Agreeableness		–0.13		–0.27**		–0.05		–0.30**
Conscientiousness		–0.01		–0.14*		0.14		–0.12
Neuroticism		0.15*		0.03		0.21**		0.09
Openness		0.00		0.03		0.09		0.09
R ²	0.010	0.066	0.033	0.191	0.002	0.038	0.027	0.213
R ² adjusted	0.003	0.048	0.026	0.175	–0.005	0.019	0.020	0.198
R ² change	0.010	0.056	0.033	0.157	0.002	0.036	0.027	0.186
F	1.43	3.65**	4.82**	12.17**	0.28	2.03*	3.89**	13.97**

Note: “AW”, aggressive warning; “HAR”, hostile aggression and revenge.

* p < 0.05.

** p < 0.01.

than the younger age groups. Female drivers aged between 49 and 60 years perceived more AW of other drivers.

We validated the DAIS in a Chinese sample and performed a comparison with other countries. We found that DAIS showed a stable

two-factor structure and acceptable internal consistency, applying to a sample in Beijing, China. The two-factor structure in this study was consistent with that of other countries, although the items of each factor were different (Kováčová et al., 2014; Özkan et al., 2010).

Table 5A

Descriptive statistics of dependent variables according to sex and age (20–41 years).

	Age (20–32 years)			Age (33–41 years)		
	Male	Female	Total	Male	Female	Total
	N = 72	N = 36	N = 108	N = 79	N = 34	N = 113
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Self_AW	1.26(0.75)	1.17(0.74)	1.23(0.74)	1.19(0.68)	1.40(0.75)	1.26(0.71)
Self_HAR	0.48(0.68)	0.27(0.55)	0.41(0.64)	0.52(0.70)	0.57(0.92)	0.54(0.77)
Other_AW	1.56(0.68)	1.45(0.81)	1.53(0.73)	1.59(0.78)	1.66(0.65)	1.61(0.75)
Other_HAR	0.60(0.66)	0.44(0.55)	0.55(0.63)	0.69(0.75)	0.64(0.75)	0.67(0.74)

Table 5B

Descriptive statistics of dependent variables based on sex and age (42–60 years).

	Age (42–48 years)			Age (49–60 years)		
	Male	Female	Total	Male	Female	Total
	N = 66	N = 34	N = 100	N = 69	N = 32	N = 101
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Self_AW	1.25(0.81)	1.24(0.70)	1.25(0.77)	1.33(0.76)	1.59(0.65)	1.41(0.73)
Self_HAR	0.69(0.75)	0.72(0.94)	0.70(0.82)	0.68(0.80)	0.78(0.83)	0.72(0.81)
Other_AW	1.58(0.70)	1.38(0.66)	1.51(0.69)	1.50(0.84)	1.96(0.78)	1.64(0.85)
Other_HAR	0.80(0.74)	0.78(0.81)	0.79(0.76)	0.75(0.78)	0.99(0.90)	0.82(0.82)

Note: “AW”, aggressive warning; “HAR”, hostile aggression and revenge.

Among the 13 DAIS items, cut off (item 1), flashed lights (item 8) and sounded horn (item 12) were loaded on AW for both *self* and *others* part; these items are considered to be of low aggression degree. The remaining items, which were considered to represent a more severe form of aggression were loaded on HAR. The frequencies of these aggressive driving behaviors varied among countries. According to descriptive analysis, drivers committed relatively more AW than HAR. Compared with European countries, the frequencies of these behaviors in China were relatively high, and similar to those obtained in Turkey (Kováčsová et al., 2014; Özkan et al., 2010). For example, the subjective reports of “physically attacked” “rammed a vehicle” and “threatened physically” were almost non-existent in Finnish, British, Dutch and Slovak samples, while they were much more abundant in Turkish and Chinese samples (Kováčsová et al., 2014; Özkan et al., 2010, 2011). This can be explained by several reasons. On the one hand, a few items may have different meanings in different cultures; for example, “headlight flashing” and “honking” suggest aggressiveness in the UK (Lajunen et al., 2004), while they may reflect polite reminders to other drivers in China. On the other hand, traffic in China and Turkey is more chaotic; according to WTO reports (2013 & 2015), total registered vehicles had increased by about 20% in both China and Turkey during 2010–2013, with drivers exposed to a greater incidence of events such as prevention from manoeuvring, or ramming a vehicle (Özkan et al., 2011). Furthermore, Turkey and China are middle-income countries in rapid growth, while the UK, the Netherlands, and Finland are developed countries. This may reflect differences among developing and developed countries. There are several studies involving countries of different economic levels, indicating that safety attitude, unsafe driving behaviors, and risk perception varied among countries (Lund and Rundmo, 2009; Nordfjærn et al., 2014; Özkan et al., 2006; Şimşekoğlu et al., 2013; Warner et al., 2011). Notably, in developed countries, infrastructure and traffic rules are quite complete compared with developing countries. Thus, traffic environment may be similar among countries of comparable economic levels.

We initially expected to explore the empirical validity of the DAIS though associations of traffic accidents with DAIS parameters.

Table 6

MANOVA tests and effect sizes.

		F	η^2
Main effect of age	self_AW	2.01	0.01
	self_HAR	4.50**	0.03
	other_AW	2.07	0.01
	other_HAR	3.88**	0.03
Main effect of sex	self_AW	1.39	0.00
	self_HAR	0.01	0.00
	other_AW	0.53	0.00
	other_HAR	0.01	0.00
Interaction between age and sex	self_AW	1.26	0.01
	self_HAR	0.77	0.01
	other_AW	3.37*	0.02
	other_HAR	1.19	0.01

Note: “HAR”, hostile aggression and revenge; “AW”, for aggressive warning.

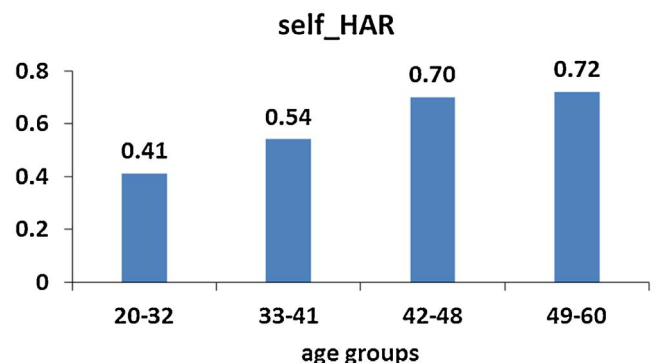
* $p < 0.05$.** $p < 0.01$.

Fig. 1. Main effect of age on self_HAR.

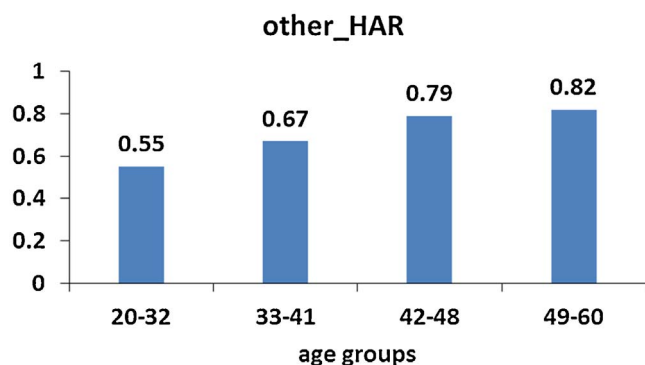


Fig. 2. Main effect of age on other_HAR.

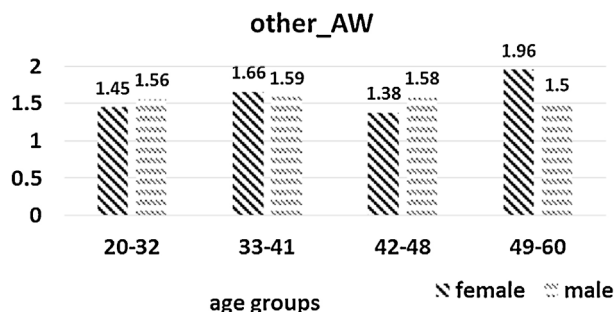


Fig. 3. Interaction between age and sex on other_AW.

However, we found no significant correlation between DAIS and accidents during the last three years. It should be noted that traffic accidents are rare and non-normally distributed. Therefore, the correlation between aggressive driving and accidents is hard to obtain. Further, participants may report fewer accidents for social desirability.

Concerning the big five personality traits, significant associations were found of neuroticism, agreeableness, and conscientiousness with aggressive driving. We found that higher score of neuroticism predicted increased self_AW and other_AW. Neuroticism refers to a relatively stable tendency to respond with negative emotions to threat, frustration, or loss (Lajunen et al., 2004). Therefore, individuals might be easily angered or frustrated, which in turn triggers AW. This finding is consistent with previous studies demonstrating that neuroticism is a stable personality trait predicting more aggressive driving behaviors (Aniței et al., 2014). Besides, neuroticism is also related to more accident involvement and traffic violation (Arthur and Doverspike, 2001; Guo et al., 2016; Jovanović et al., 2011).

Our results suggest that agreeableness was associated with less self_HAR and other_HAR. Aniței et al. (2014) found that low level of agreeableness predicts enjoyment of violence. Furthermore, Benfield et al. (2007) found that less agreeableness is correlated with more revenge and retaliation as well as physically aggressive thoughts. This might explain why less agreeableness predicted more HAR, which corroborated other studies indicating that less agreeable drivers exhibit more driver-related aggression and less careful driving style (Benfield et al., 2007; Harris et al., 2014; Jovanović et al., 2011; R. Taubman-Ben-Ari and Yehiel, 2012).

The personality trait of conscientiousness was associated with less self_HAR behaviors. Conscientious individuals tend to be organized, dependable, and self-disciplined, and might be less willing to break traffic rules. In addition, high degree of conscientiousness predicts reduced anger in a study of young drivers (Aniței et al., 2014). Previous studies also found that conscientiousness was related to fewer crashes or reckless driving (Arthur and Doverspike, 2001; Harris et al., 2014; Taubman-Ben-Ari and Yehiel, 2012). It should be mentioned that unlike neuroticism and agreeableness, conscientiousness did not predict HAR committed by other drivers. Conscientiousness might be a trait that

mostly focuses on requirements for oneself, so that it does not predict other drivers' aggressive behaviors.

Three things need to be mentioned regarding the relationships among personality traits and DAIS parameters. First, the above results suggested that personality traits not only predicted aggressive driving committed by themselves, but also others drivers' aggressive driving behaviors perceived. This implies that perception of other drivers is influenced by the driver's own personality; a neuroticism driver perceived more aggressive behaviors. This bias could influence their own driving (Özkan et al., 2010). However, these findings were based on subjective rating by participants; in further study, objective data would provide more accurate conclusions. In addition, AW and HAR were predicted by different personality traits. This confirms that these two factors are separate constructs. There might be deeper reasons why neuroticism predicted AW, while agreeableness/conscientiousness predicted HAR. Finally, in some studies, openness and extroversion were also shown to predict driving accidents and aggressive driving behaviors (Benfield et al., 2007; Harris et al., 2014; Taubman-Ben-Ari and Yehiel, 2012). However, we did not find a significant effect of openness and extroversion.

As for the age factor, we found that older drivers reported a higher frequency of HAR acts. Older drivers also perceived more HAR by others. However, in previous studies, older drivers were shown to be less aggressive driving behaviors and more careful, avoiding risky driving behaviors in contrast to young drivers (Dahlen and White, 2006; Gwyther and Holland, 2012; Lourens et al., 1999; Shinar et al., 2001). Interestingly, the factors associated with older driver perception and HAR acts remain unclear. In a recent study, Chinese high-speed railway drivers also found that older age was a significant predictor of accident involvement (Guo et al., 2016). We considered that there might be cultural factors related to this phenomenon. China has been in a rapid developing stage during the last several decades; the social changes trigger several changes, including improvement of educational level. Younger participants are associated with higher education (Table 2 in the Results: age was negatively correlated with years of education, $r = -0.23$, $p < 0.05$). Higher education was correlated with more agreeable and less aggressive behaviors. In addition, researchers found that older people were more agreeable and conscientious, and less neurotic (Soto et al., 2011; Lucas and Donnellan, 2009; Smits et al., 2011). However, in the current study, age and these personality traits showed inverse correlations. This may also be due to social changes, with Chinese becoming more open-minded and conscientious (Mingjie and Jianxin, 2007), which help them adapt to the changing society. Therefore, people of different ages were influenced deeply by social changes in China. Besides, people have more respect and tolerance in older age in the Chinese culture, which might be the reason why we found the above unusual effect of age on aggressive driving.

In terms of sex, male and female drivers showed no differences in aggressive driving behaviors. However, females aged between 49 and 60 years perceived more AW acts by other drivers than male or other female drivers. This indicated that 49–60 years old females were more sensitive to aggressive warnings on the road. Besides, the MANOVA results showed that the age and sex effect size was quite small, implying that age and sex may not be strong predictive factors of aggressive driving behaviors.

4.2. Limitations

First, aggressive driving and traffic accidents were based on subjective reports, which may be influenced by social desirability. Objective measurements such as driving simulation and natural observations are needed to compensate for the deficiency. Second, we found no correlation between aggressive driving and self-reported accidents, implying that the empirical validity could not be confirmed. More objective indices of driving performance should be used as

empirical criteria. Besides, other aggressive driving measurements should be employed as references to ensure the convergent validity of the DAIS. Third, how personality traits influence aggressive driving remains to be explored. The relationship between personalities and aggressive driving may be mediated by factors and trait such as the way to dispose anger. Finally, the participants were recruited only in one city of China; sample representativeness may be improved by recruiting participants from different provinces of China.

5. Implications

This is the first study translating and validating the DAIS in China. It shows a clear factor structure and internal consistency. Aggressive driving plays an important role in traffic safety; the current scale can help identify dangerous drivers, and be used by traffic organizations and driving schools. Furthermore, personality traits are effective predictors of aggressive driving behaviors. For example, neurotic drivers should cultivate patience and improve tolerance under bad traffic conditions. For further research, the mechanism underlying associations of personality traits with the DAIS should be explored. As for age and sex differences, older age was associated with more aggressive driving, which remind us paying attention to the age group of 42–60 years.

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