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A model of Beijing drivers' scrambling behaviors

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ABSTRACT

A major, but unstudied, cause of crashes in China is drivers that "scramble" to gain the right of way in violation of traffic regulations. The motivation of this study is to explore the features of drivers' scrambling behaviors and the attitudes and driving skills that influence them. In this study, we established a scrambling behavior scale, and developed a driving attitude scale and a driving skill scale using factor analysis of an Internet survey of 486 drivers in Beijing. A structural equation model of scrambling behavior toward cars and pedestrians/cyclists was developed with attitudes and skills as predictors of behavior. Skills and attitudes of approval toward violations of traffic rules did not predict scrambling behaviors, while the motivation for safety and attitudes against violating traffic rules led to reduced scrambling behaviors. The current work highlights this peculiar aspect of Chinese roads and suggests methods to reduce the behavior.

1. Introduction

In recent years, urbanization and motorization in China have increased rapidly, along with social and economic development. The number of motor vehicles in Beijing exceeded 4 million in December 2009. The increasing amount of traffic results in frequent crashes and has serious negative impacts on the rapid development of cities. In China's urban areas, conflicts between motor vehicles and pedestrians/bicyclists, and conflicts between motor vehicles are very prevalent. It is common to see vehicles in China making turns scramble to pass through the intersection while pedestrians are crossing intersections and left turning vehicles scramble to pass through the intersection despite other vehicles driving straight in the opposite direction. In 2009, 238,351 crashes resulting in damage or injury were reported in China. These crashes resulted in 67,759 deaths. Crashes at intersections account for about 30% of the total crashes in China (Pei and Ma, 2005). Crashes often occur at intersections when drivers "scramble" to gain the right of way in violation of traffic regulations.

The reason for these "scrambling" driving behaviors is not clear. Scrambling behaviors are defined as the behaviors of drivers, pedestrians, or cyclists that challenge for right of way in violation of traffic codes. Examples of drivers' scrambling behaviors include making turns that do not yield the right of way to pedestrians crossing intersections, right turning vehicles not yielding the right of way to left turning vehicles coming from the opposite direction at intersections, and left turning vehicles at intersections not yielding the right of way to other vehicles driving straight in the opposite direction. Scrambling behaviors are frequent in Chinese cities. Pedestrians or cyclists' scrambling behaviors such as failing to stop at a red light are also prevalent.

Li et al. (2006) observed the phenomenon of "pedestrians running the red light" at two locations in Nanjing, showing that less than 30% pedestrians observe traffic regulations. Scrambling behaviors among drivers are also prevalent but have not attracted as much attention from researchers. However, statistics show that drivers' scrambling behaviors is an important factor in traffic crashes in China. Drivers' scrambling behaviors account for between 14.4% (Mao et al., 2009), and 16.4% (Qiu et al., 2007) of crashes on Chinese roads. Understanding scrambling behaviors and rectifying drivers' scrambling behaviors would help to reduce the number of crashes, improve safety conditions, improve traffic efficiency and help to protect pedestrians, bicyclists and other traffic vulnerable groups.

The current study focuses on this important, yet poorly understood, driving behavior that is peculiar to Chinese roadways. There are many differences between Chinese drivers and drivers in Western countries where cars have been more widely available for a longer period of time. First, China has the largest cycling population in the world, and Chinese car drivers of the present generation often convert to motor vehicles after using bicycles for some years. However, bicycle use and car use have several differences, including the fact that regulation of cyclist on-road behavior is less strict than regulation of driver behavior. Second, most western drivers obtain a license and start driving at an earlier age. Western drivers develop

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a familiarity with road safety and rules when they are very young. Third, as the number of motor vehicles in China has increased rapidly, private vehicles have become more prevalent in families. Driver training and education has shifted from private training of professional drivers to public driving schools, where training can be less strict and shorter in duration. This change may result in reduced driving skill, as well as ignorance of traffic codes and potentially lead to more aberrant driving behaviors such as scrambling for right of way. Also, there is a large population density and a large number of pedestrians in Chinese urban cities. Vehicles as well as pedestrians/bicyclists scramble to pass through the intersections to avoid delays. These numerous differences require that we study the population of Chinese drivers directly to understand problems unique to Chinese roadways. Comparison of Chinese driver behavior to the behavior of Western drivers also has the potential of improving understanding of driver behavior in both groups. The current work will develop a preliminary model of scrambling behavior by defining scrambling behavior, and examining the potential contributions of attitudes and skills toward the behavior.

Defining driving behaviors has typically been accomplished using survey techniques. Western driver behavior has been examined using measures such as the Driver Behavior Questionnaire (DBQ) (Reason et al., 1990). The DBQ was first developed by the Manchester Driving Behavior Researching Group to study self-reported aberrant driving behaviors and their relationship with different variables and crash involvement. Research using the DBQ finds three different types of driving behaviors: violations, errors, and slips or lapses. Errors were defined as an unintentional "failure of planned actions to achieve their intended consequences" and violations were defined as "deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system" (Reason et al., 1990). Slips and lapses include failures of memory and attention. This three-factor structure of driving behaviors has been confirmed by additional research (Parker et al., 1995) and subsequent research has further explored the nature of these variables in more detail (see Lawton et al., 1997; Parker et al., 1998).

Over the years, researchers have used the DBQ approach to study differences in driver behavior in their countries. In China, Xie and Parker (2002) used the DBQ to develop a Chinese Driving Questionnaire (CDQ) and collect driving data in Beijing and Chengde. The CDQ included culture-specific topics such as questions concerning social hierarchy and interpersonal networks. It was administered along with an extended version of the DBQ. Factor analysis of the CDQ items revealed four factors: the sense of social hierarchy, potential road safety countermeasures, belief in interpersonal networks, and challenging legitimate authority.

The DBQ and CDQ analysis results showed that Chinese driving behavior includes factors not seen in similar research in other countries, suggesting research conducted in Western countries may not strictly apply to Chinese drivers. Following this approach, Shi et al. (2010) applied the DBQ approach to study Beijing motor vehicle drivers' aberrant driving behaviors and extend development of a driving behavior questionnaire concerning Chinese driving behavior characteristics. They used the Internet as a tool for data collection. The distinction between violations and errors found in previous studies was confirmed. It was found in their study that: violations included "emotional violations", "risky violations" and "self-willed violations", and errors included "errors due to inexperience" and "errors due to distraction"; on-road experience was the key to risk for Chinese drivers, with increased experience reducing errors. They also found that: there was good agreement between a paper-based version of the survey and the Internet version, the results of the paper-based and Internet version of the surveys were very similar; the results from the Internet survey were very consistent with previous work in and outside of China using paper-based methods; it was able to obtain a large sample with this method easily, making the sample size sufficient for factor analysis compared to the paper-based survey; Internet users and private car owners both have high incomes in China, the Internet survey can be considered to obtain a representative sample. On the other hand, anonymity of an Internet survey might offset the effect of social desirability. These results indicate online surveys to be a feasible way to conduct research of driving behavior. In the current work, we will apply this approach used in Shi et al. (2010) to define scrambling behaviors in Chinese drivers.

In addition to defining scrambling behaviors, the current works seeks to understand why these behaviors occur. In general, research on driving behavior focuses on two components: attitudes and skills. Attitudes are defined as a favorable or disfavorable cognitive, affective or behavioral response to an entity or event (Eagly and Chaiken, 1993). Models such as the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975) and the Theory of Planned Behavior (TPB) (Ajzen, 1985) have been developed to account for the relationship between attitudes and behaviors. In an application to driving research, Parker et al. (1992) used TPB to measure attitudes and intentions of drivers toward four driving violations: drunk driving, speeding, close following, and dangerous overtaking. They concluded that attitudes toward behaviors, subjective norms and perceived behavioral control were predictors of violations, supporting the importance of understanding attitudes in relation to driving behaviors.

Driving skills have been examined using tools such as the Driving Skill Inventory (DSI) (Lajunen and Summala, 1995 which was based on Spolander, 1983; Hatakka et al., 1992). The inventory was developed to measure a driver's perceptual-motor and safety skills. In the DSI, drivers are asked to assess their driving skills. Research with the DSI suggests there are two factors that emerge: driving skill and fluency (knowledge of rules and laws) and the safety-motivation factor which includes concern for safety and anticipatory driving behaviors.

The current work will include measures of driving skills as well as driving-related attitudes to predict the occurrence of scrambling behaviors in Chinese drivers. A low cost Internet survey will be used to collect survey data similar to Shi et al. (2010). The work of Shi et al. with Chinese drivers and Atchley and colleagues with younger drivers (Atchley et al., 2011; Nelson et al., 2009) suggest anonymous surveys can honest assessments of even unlawful driver behavior. Because attitudes or driving skill measures have not been developed for Chinese drivers, the current work will develop measures of attitudes by taking Chinese translations of previous tools such as the DSI as well as developing new instruments to measure driver attitudes toward violations, using factor analysis to determine the best fit for Chinese drivers. A measure of scrambling behavior will be developed using a similar factor analytic technique. We will finally apply structural equation modeling to the data and make predictions of when scrambling behavior is likely to occur. These data will support the ability to improve traffic safety on Chinese roads.

2. Method

2.1. Participants

A link to a survey entitled "Survey of Car Drivers' Driving Behavior in Beijing" was published on the homepage of http://auto.sohu.com, one of the most popular automobile-themed websites in China. The participants were restricted to car drivers who have resided in Beijing in the last year. We provided gifts for the participants in a random drawing to attract more drivers to participate. The survey was anonymous to encourage honest responses. 511 responses were collected in 11 days. Duplicate and unusual cases were identified and removed. The remaining 486 cases accounted for 95% of the sample and covered all 18 administrative districts of Beijing. Among these, 70% were male and 30% were female, similar to the sex ratio of Beijing drivers. The sample comprised 78% married participants and 72% had a university or college education. Forty-seven percent had less than 3 years of driving and 90% were driving private cars. The majority (97.5%) had used bicycles before. The mean age was 32.6 years (mode 30 years) and the age ranged from 18 to 65 years.

2.2. Measures

The questionnaire used in this study included four parts.

Part one measured demographics: gender, age, educational marital status, years of driving, car ownership, current bicycle use and years of bicycle use. These data were used for different study than the one reported here.

Part two measured self-reported scrambling behavior. We used a scale in which participants indicated how frequently they performed the described behavior in the past year. The 11 items of the scale were adapted from the clauses in traffic codes and were approved by the traffic police we interviewed to be typical and prevalent. Seven items described scrambling behavior toward cars and the other four items toward pedestrians and bicyclists. The ratings ranged from 1 to 5: 1 – never, 2 – hardly ever, 3 – sometimes, 4 – frequently, 5 – nearly all the time. To avoid reluctance of participants to indicate their frequency of scrambling behaviors, the items were adapted to the opposite of scrambling behaviors, i.e., yielding behaviors. In later analysis, the ratings of the items were converted to indicate the frequency of scrambling behaviors.

Part three measured driving attitudes. Items were developed through interviews with car drivers. We recruited a group of 10 drivers as our interviewees. The main topic of the interview was to discuss what factors would affect a driver's choice to violate traffic codes. Ten factors such as time pressure, safety, punishment, scrambling and the urgency of other drivers were summarized to be influential with the first three considered to be the most important. Based upon these factors, 14 items measuring drivers' attitude were developed. Nine items pertained to general attitude toward driving violations and two items were about the attitudes toward pedestrians. An additional three were developed to reflect drivers' attitude concerning their bicycle use, for use in a different study. The participants were asked to respond the items in the 5-point Likert scale where 1 referred to "totally disagree" and 5 referred to "totally agree".

Part four consisted of a 10-item adaptation of the Driver Skill Inventory (DSI). Participants were asked to report how much the description of items fit their driving skills and safety motivation. We first chose 10 items with relatively high factor loadings from the DSI and translated them into Chinese. The options of the items ranged from 1 ("does not apply to me at all") to 5 ("applies to me fully"). The term "fluent" ("fluent overtaking" and "fluent driving") was used in Lajunen and Summala (1995). "Fluent overtaking" means drivers consider they are good at driving skill so they can overtake safely. "Fluent driving" means these drivers consider they are good at driving and they can master the vehicle in every situation.

2.3. Statistical analysis

Confirmatory factor analysis was conducted to examine the scrambling behavior scale and the driving attitude scale, also the interrelation between the scales. Indices including the Root Mean Square Error of Approximation (RMSEA), Non-Normed Fit Index (NNFI), Comparative Fit Index (CFI), Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) were used to test the model fit. Based on Hou (2004), we considered a model with RMSEA of less than 0.08, and NNFI, CFI, GFI and AGFI of above 0.90 as acceptable (but see Hu and Bentler, 1999 for alternatives).

Exploratory factor analysis was used to find the dimensions of the driving skill scale. At first, Minimum Average Partial (MAP) and Parallel Analysis (PA) were used to determine the number of factors to be retained. Then Principal Component Analysis (PCA) with direct oblimin rotation was carried out to examine whether the two factors had a strong correlation. After that, PCA with varimax rotation was conducted to determine the factor loadings of the items. Cronbach's alpha coefficients were calculated to evaluate the internal reliability. According to Nunnally's criterion, a scale should have an alpha of 0.70 or above to be considered as reliable.

Structural equation modeling (SEM) was used to model scrambling behavior based on the data from the scales. SEM was used here to consider the influence of attitude and driving skill on scrambling behaviors. Instead of using traditional regression analysis and ANOVA analyses, SEM was employed. Researchers have begun to introduce SEM to the traffic field (Atchley et al., 2011; Golob, 2003; Nelson et al., 2009) because it is an analytic procedure that does an excellent job of accounting for measurement error. As Nelson et al. (2009) point out, traditional multivariate techniques are affected by the unreliability of measurements. Traditional factor analysis cannot assess causal relations. On the other hand, SEM can test relationships between multiple constructs and handle measurement error simultaneously, helping to build more accurate models of behavior.

In the current work, attitude and driving skill are exogenous latent variables and scrambling behaviors are endogenous latent variables. Given the paucity of work with Chinese drivers on this topic, we have chosen an exploratory factor analytic technique to develop the constructs for the structural model (Mulaik, 2009). We predict that scrambling will consist of two factors: scrambling toward other cars and scrambling toward pedestrians and cyclists. The general model of interest is one in which scrambling behaviors are predicted by attitudes toward violations, driving skill, and a motivation to drive safely. Generally, we predict a decrease in all scrambling behaviors as a function of increases in skill, motivation for safety and a negative view of traffic violations.

3. Results

3.1. Structure of the scrambling behavior scale

Confirmatory factor analysis was carried out to examine the items measuring scrambling behavior. Seven items (1, 3, 4, 5, 7, 9, 10) described scrambling behavior toward cars and the other four items (2, 6, 11, 12) toward pedestrians and bicyclists. To examine the fitness of this solution, LISREL was applied. The goodness-of-fit indices suggested a reasonable fit ($\chi^2 = 214.99$, df = 43; RMSEA = 0.090; NNFI = 0.94, CFI = 0.96; GFI = 0.93; AGFI = 0.89). Factor loadings of all items were high (0.38–0.78), but the AGFI was low (0.89). Factor loadings of items 1, 2, 3, 4 were the lowest of all items, so the model was recalculated after removing these four items. The results showed improved model fit: ($\chi^2 = 42.81$, df = 13; RMSEA = 0.068; NNFI = 0.98 CFI = 0.99, GFI = 0.98, AGFI = 0.95). The remaining two factors had four items (5, 7, 9, 10) describing scrambling behavior toward cars and three items (6, 11, 12) describing scrambling behavior toward pedestrians and bicyclists. Mean responses and factor loadings for scrambling behaviors are shown in Table 1. A high mean score indicated high frequency of scrambling behaviors.

3.2. Structure of the driving attitudes scale

The driving attitude questions consisted of three sub-scales: general attitudes toward violations, attitudes toward cars yielding

Table 1
Means and factor loadings for scrambling behavior.

Items	Mean (standard deviation)	Factors	
		Scrambling behavior toward pedestrians and bicyclists	Scrambling behavior toward cars
B6. Dodge pedestrians on roads without sidewalks or traffic lights (R)	1.68 (0.89)	0.75	
B11. Stop for pedestrians on sidewalks without traffic lights (R)	1.89 (0.82)	0.77	
B12. Give way to bicyclists and pedestrians going straight on the right hand when turning right (R)	1.97 (0.87)	0.75	
B5. Give way to vehicles which were entering side roads from main roads (R)	2.06 (0.83)		0.60
B7. Give way to vehicles in roundabouts at the entrance of the roundabout (R)	1.86 (0.81)		0.81
B9. Give way to vehicles in main roads when entering the main road from side roads (R)	1.72 (1.04)		0.77
B10. Give way to vehicles going straight in the opposite direction when turning left at crossroads (R)	1.78 (0.86)		0.70

to pedestrians and drivers' attitude concerning their bicycle use. A factor analysis of the first sub-scale was performed (described below). The second sub-scale was used to measure drivers' attitude toward "car should yield to pedestrians". The mean scores of the two items on the second sub-scale were almost equal (C5: "If there are lots of pedestrians on the way of cars, cars should give way to pedestrians." = 3.85, C10: "Sometimes it is OK to push through the crowds if they are in my way." = 3.84, reverse scoring item 10). The average of the two items was computed, and used in the structural model. Questions about bicycle use were not included in analyses in the current work.

For general attitudes toward violations we applied a three-factor solution (time pressure, safety, and punishment) as motivated by the interview data, but the results were unsatisfactory. The factor analysis could not find an acceptable three-factor solution. A two-factor solution with four items (1, 6, 8, 9) related to attitudes against violations and four items (2, 4, 7, 11) related to attitudes toward approval of violating traffic regulations under certain circumstances produced a better fit. Factor loadings of all items were good (0.44–0.83), and the goodness-of-fit indices suggest an acceptable model fit (χ^2 = 39.47, df = 19; RMSEA = 0.044; NNFI = 0.98 CFI = 0.98, GFI = 0.98, AGFI = 0.96). The correlation coefficient between attitudes disapproving of violations and attitudes approving of violations was −0.42. Means and factor loadings are shown in Table 2.

3.3. Structure of the driving skills scale

Exploratory factor analysis was used to find the dimensions of the driving skill scale. Items with factor loadings less than 0.3 were omitted. Item 3 was removed because it had a loading on each factor of over 0.4. The remaining items resulted in a driving skills factor (items 1, 5, 7 and 9) and a safety motivation factor (items 2, 4, 6, 8, 10). Factor loadings of all items were good (0.64–0.86), and the goodness-of-fit indices suggest an acceptable model fit (χ^2 = 103.29, df = 24; RMSEA = 0.081; NNFI = 0.95 CFI = 0.97, GFI = 0.96, AGFI = 0.92). The correlation coefficient between the two factors was 0.37. Means and factor loadings are shown in Table 3.

3.4. Model of scrambling behavior

Structure equation modeling was used to examine the influence of attitudes and driving skills on scrambling behaviors. The results of the model are shown in Fig. 1. The goodness-of-fit indices suggest the model fit well (χ^2 = 584.11, df = 278; RMSEA = 0.047; NNFI = 0.97 CFI = 0.97, GFI = 0.92, AGFI = 0.89). Driving skills and attitudes approving of violations were not significantly correlated to the two kinds of scrambling behaviors. Attitudes toward cars yielding to pedestrians had a negative correlation with scrambling behavior toward pedestrians, but not toward other vehicles. Attitudes disapproving of violations and safety motivation showed a significant negative correlation to the two types of scrambling behaviors.

4. Discussion

The current study examined a traffic behavior that is prevalent on Chinese roads, but which is not as common in other countries, nor which has been studied closely. This "scrambling behavior" is characterized by the willingness of a driver to violate traffic rules to establish right of way in relation to other vehicles or pedestrians and bicyclists. This includes an unwillingness to give way to vehicles entering roadways or making turns across traffic, or yielding to pedestrians on roads and uncontrolled sidewalks. Due to a lack of systematic study of this behavior, it is not clear if scrambling is

Table 2
Means and factor loadings for attitudes toward violations.

Items	Mean (standard deviation)	Factors	
		Disapprove of violations	Approve of violations
C6. Regardless of punishment, violation is not acceptable for safety	4.07 (0.99)	0.67	
C9. I could not live with myself if I hurt another human being with my car for violation	4.31 (0.80)	0.56	
C1. Traffic codes must be obeyed even under time pressure	4.14 (1.07)	0.49	
C8. I would definitely not violate traffic codes if it is possible to be punished	3.91 (1.05)	0.44	
C2. Sometimes it is OK to violate traffic codes if there will be no punishment	3.68 (1.02)		0.83
C11. Violation is acceptable if it is safe and there is no punishment	3.54 (1.10)		0.76
C7. I think it is OK to violate traffic codes in traffic jam	3.92 (0.93)		0.66
C4. If there is an emergency, I do not care whether I violate the traffic codes	3.47 (1.12)		0.62

Table 3
Means and factor loadings for driving skill.

Items	Mean (standard deviation)	Factors	
		Driving skills	Safety motivation
D9. I overtake fluently	3.42 (0.97)	0.86	
D5. I fluently change lanes in heavy traffic	3.66 (0.97)	0.82	
D1. I drive fluently	3.79 (0.96)	0.82	
D7. I react fast in driving	3.96 (0.78)	0.73	
D10. I avoid unnecessary risks	4.25 (0.76)		0.73
D4. I avoid competition in traffic	3.92 (0.93)		0.72
D8. I conform to the speed limits	4.13 (0.97)		0.72
D2. I drive carefully	4.16 (0.78)		0.71
D6. I keep sufficient following distance	4.07 (0.81)		0.64

due to a general lack of skill on the part of drivers, an unconcern for safety, or a willingness to break traffic laws to gain advantage in traffic.

To begin an investigation of this phenomenon, we established a scrambling behavior scale based on the clauses in traffic codes and interviews with drivers and traffic police. We also developed a driving attitude scale and a driving skill scale. Following a previously established method (Shi et al., 2010) we used the Internet to deliver the surveys to a sample of Beijing motor vehicle drivers. Factor analysis of the scrambling behavior questions revealed that scrambling behavior is not one set of behaviors, but rather two sets of behaviors, one directed toward cars and one toward pedestrians and cyclists. The initial interviews suggested a possible three-factor solution of time pressure, safety and pun-

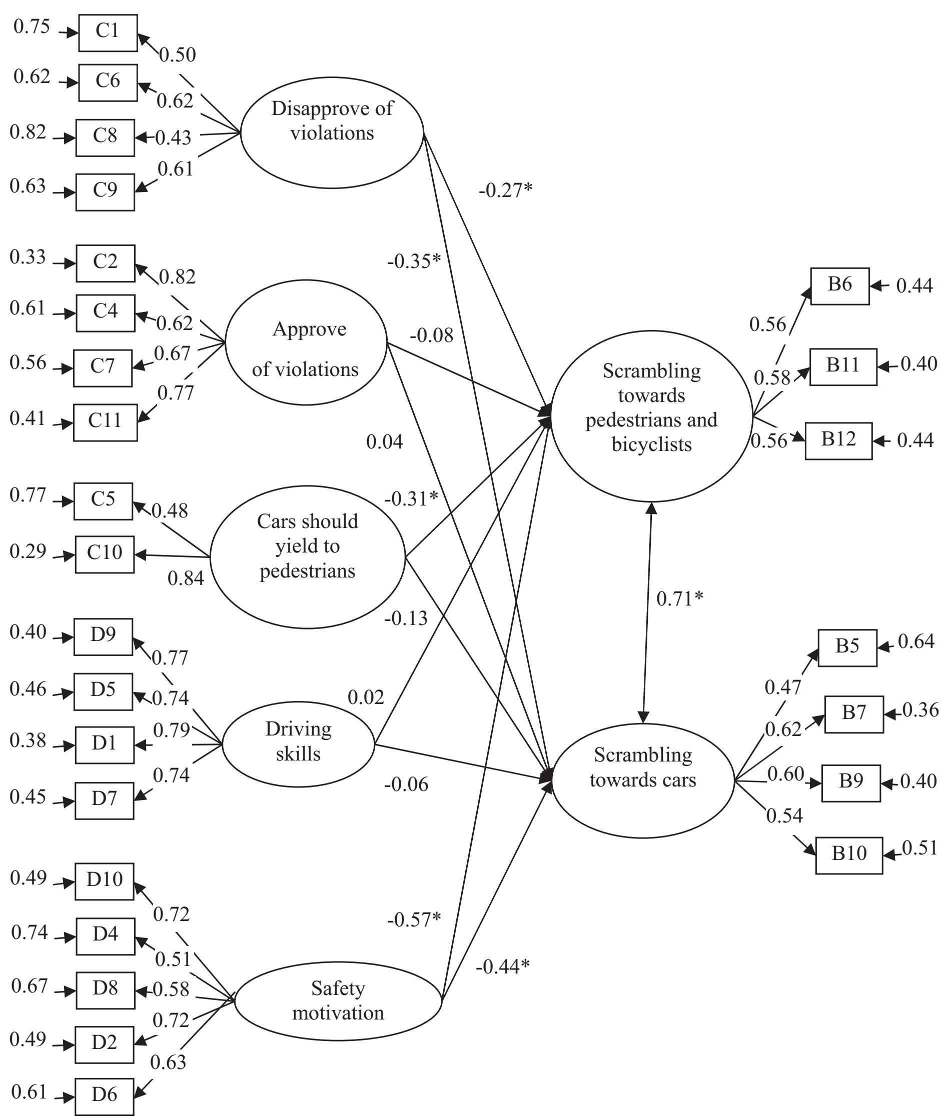

Fig. 1. Results of the structural model. The five predictors are on the left. The scrambling behaviors are on the right. Significant beta weights are indicated by asterisks.

ishment for attitudes toward violations, but the factor analysis revealed two factors: attitudes disapproving of violating traffic laws and attitudes approving of violating traffic laws under certain circumstances. We also included two questions on attitudes toward yielding to pedestrians to form a third attitudes sub-scale. Analysis of the questions based upon the Driving Skill Inventory (DSI) (Hatakka et al., 1992; Lajunen and Summala, 1995; Spolander, 1983) revealed a similar two-factor structure to that found previously: driving skills and safety motivation.

We entered the five predictors from the scales (attitudes disapproving of violations, attitudes approving of violations, attitudes toward pedestrians, driving skill, and safety motivation) and the two scrambling behaviors (scrambling toward cars and scrambling toward pedestrians and bicyclists) into a structural equation model to better understand why scrambling behaviors take place. The division of scrambling into two sets of behaviors was confirmed in the structural model. Although scrambling toward pedestrians/bicyclists and scrambling toward cars were strongly, positively, related, attitudes toward pedestrian safety led to a decline in scrambling behaviors toward pedestrians/bicyclists alone. In other words, drivers concerned about pedestrians and bicyclists reduce scrambling toward those groups, but may still maintain a pattern of scrambling behavior in general traffic. These results verified the hypothesis that scrambling behaviors are due, in part, to driver attitudes, and not just driver skill, similar to previous studies (West and Hall, 1997; Ulleberg and Rundmo, 2002, 2003; Fernandes et al., 2004), which showed that attitude plays a role in driving behaviors.

While attitudes are important predictors of scrambling behaviors, not all attitudes successfully impact scrambling. Specifically, attitudes disapproving and approving of traffic violations showed a differential effect on scrambling. While drivers that generally disapprove of violating traffic laws were reported fewer scrambling behaviors overall, drivers that approve of violating traffic rules, for example to improve their position in a traffic jam (question C7), did not show an elevated level of scrambling. In other words, attitudes seem to result in reduced scrambling behaviors, but they do not seem to result in increases in the same behavior. A similar pattern is seen in the relationship between safety motivation and scrambling, where safety motivation had a strong impact on reducing scrambling behaviors, consistent with previous work (Lajunen et al., 1998a,b), despite the fact that self-assessed driving skill had no impact on scrambling behaviors.

It seems, then, that scrambling is a set of behaviors that is not due to lack of driver skill or a willingness to break traffic laws, but it is rather a set of behaviors to gain the right-of-way advantage that may be present in most drivers, but are inhibited by a concern for safety, and a disapproval of violating traffic laws. Drivers specifically concerned with pedestrian safety had fewer scrambling behaviors toward pedestrians but this did not translate to a reduction of scrambling toward cars, again supporting the idea that a general tendency toward scrambling behaviors in Beijing drivers is reduced by a concern for safety, though for some of these drivers it may be pedestrian specific.

In conclusion, this study established a scrambling behavior scale to consider a particularity of China's roadways. Development of a driving attitudes scale and a driving skill scale and subsequent modeling revealed that scrambling behaviors are inhibited by a general concern for traffic safety and a disapproval of violating traffic laws, but that this may be situation specific. The results suggest that reducing these sorts of violations will require improving concern for traffic safety more generally. It may not be necessary to specifically target scrambling behaviors in public safety campaigns, but instead raising the general concern of drivers for traffic safety toward other vehicles, bicyclists and pedestrians should reduce scrambling behaviors more generally. Further research on other potential causes of this aberrant driving behavior is needed, especially focusing on combining different methods and disciplines to explore practical behavioral intervention programs that can be delivered to large populations of drivers.

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