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An extension of the theory of planned behavior to predict pedestrians' violating crossing behavior using structural equation modeling

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ABSTRACT

This paper aimed to examine pedestrians' self-reported violating crossing behavior intentions by applying the theory of planned behavior (TPB). We studied the behavior intentions regarding instrumental attitude, subjective norm, perceived behavioral control, the three basic components of TPB, and extended the theory by adding new factors including descriptive norm, perceived risk and conformity tendency to evaluate their respective impacts on pedestrians' behavior intentions. A questionnaire presented with a scenario that pedestrians crossed the road violating the pedestrian lights at an intersection was designed, and the survey was conducted in Dalian, China. Based on the 260 complete and valid responses, reliability and validity of the data for each question was evaluated. The data were then analyzed by using the structural equation modeling (SEM). The results showed that people had a negative attitude toward the behavior of violating road-crossing rules; they perceived social influences from their family and friends; and they believed that this kind of risky behavior would potentially harm them in a traffic accident. The results also showed that instrumental attitude and subjective norm were significant in the basic TPB model. After adding descriptive norm, subjective norm was no more significant. Other models showed that conformity tendency was a strong predictor, indicating that the presence of other pedestrians would influence behavioral intention. The findings could help to design more effective interventions and safety campaigns, such as changing people's attitude toward this violation behavior, correcting the social norms, increasing their safety awareness, etc. in order to reduce pedestrians' road crossing violations.

1. Introduction

China is the world's most populous country and has the greater amount of pedestrians if everyone is considered as a pedestrian at a certain point of the day. In the midst of country's rapid urbanization and motorization, motor vehicle crashes involving pedestrians have become more and more frequent, partly because pedestrians put themselves in a risky situation either by violating traffic rules or by poor judgment. In China, the pedestrians' road-crossing behavior may be different from other countries. 40% of the travel is completed on foot, accompanied by very common traffic violations (Yang et al., 2006). According to Zhuang and Wu (2011), pedestrians preferred to crossing at unmarked roadways anxiously instead of waiting patiently at the curb. For those who decided to cross the street, 65.7% did not look around for vehicles during crossing; for those who looked at the oncoming vehicles only 11.4% stepped back and 31.9% dashed across.

As the most vulnerable road users, the pedestrian safety has been a great concern of the society. There has been a considerable amount of research trying to explore the factors that influence pedestrians' risky behavior. Koh et al. (2014) found that a person was more likely to violate on a 4-lane road with wide median compared to a 6- or 7-lane road; and when he/she was alone compared to with companions. The factors contributing to a high possibility of violation also include crossing distance, waiting time, the number of passing vehicles, and the violating pedestrians. Xu et al. (2013) studied jaywalkers and evaluated their influence of past behavior. They found that the past behavior explained 42% of the variance in pedestrians' intention to violate traffic laws. A successful previous experience to violate traffic laws at the same location would prompt the chance of repeating offenses. On the other hand, the experience of being involved in a traffic accident would constraint the pedestrian from taking risks by reducing their waiting time, as reported by Hamed (2001). When demographic characteristics such as age and gender were considered, young people were found

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to have more positive attitude toward committing violations than adults, older people were less likely to cross in risky situations, and male pedestrians reported more frequent violations of traffic rules than females (Díaz, 2002; Holland and Hill, 2007).

The theory of planned behavior (TPB), developed by Ajzen (1991), is a social psychological model that has been successfully used to predict a wide range of health behavior and intentions, According to this theory, an individual's behavior can be predicted by the behavioral intention, which is a model of an individual's (1) attitude toward the behavior, a favorable or unfavorable evaluation of the behavior of interest, (2) subjective norm, the belief about certain people that are important to the individual may approve or disapprove the behavior, and (3) perceived behavioral control, people's perceptions of the ability to perform a given behavior. Whether a variable significantly contributes to the intention to perform the behavior depends on the type of behavior assessed and the target population (Ajzen, 1991; Ajzen and Fishbein, 2005). Studies have demonstrated the use of predictive utility of TPB to better understand the decision making process of the people who violate traffic rules (Forward, 2009; Iversen, 2004; Zhou et al., 2009; Castanier et al., 2013). Studies by Evans and Norman (1998, 2003) found that the three components of the theory were significant predictors of pedestrians' road crossing intention, but perceived behavioral control emerged as the strongest predictor, indicating that people were more likely to engage when the behavior was perceived to be easy.

The contribution of subjective norms was controversial (Armitage and Conner, 2001; Hausenblas et al., 1997). Researchers argued that when trying to assess social norms, three dimensions must be taken into consideration: subjective norm, descriptive norm, and personal norm. Descriptive norm was defined as an individual's perception of the actual performance of the behavior by others in one's social network, regardless of whether this behavior was morally correct. In most of the studies with descriptive norm included, descriptive norm contributed to behavioral intention independent of subjective norm (Rivis and Sheeran, 2003; Oceja and Berenguer, 2009).

TPB has been coupled with other factors such as conformity tendency, a tendency to modify behavior when a person is around other people so as to match the perceived expectation of the social conformity. A study conducted to explore the effect of conformity tendency on pedestrians' road-crossing intentions in China (Zhou et al., 2009) found that pedestrians reported greater chance of crossing the road when other pedestrians were crossing, and people who showed greater tendency toward social conformity had stronger road-crossing intention than low conformity people.

Besides TPB, another commonly used behavior model is the health belief model (HBM), a psychological model developed in 1950s to explain and predict health-related behavior. This model includes five components: perceived benefits, perceived barriers, perceived susceptibility, perceived severity, and cues to action. Perceived susceptibility and perceived severity refer to a person's subjective perception of the chances of getting a condition and how serious a condition can be, respectively. Yagil (2000) applied HBM to study pedestrians' road-crossing behavior in relation to their beliefs regarding the consequences of the behavior, incorporating instrumental and normative motives for compliance with safety rules and situational factors. Quine et al. (1998) compared the two theories, TBP and HBM, when predicting bicycle helmet use. The results showed that TPB could explain 43% of the variance while HBM could only explain 18%. A study on the seat belt use compared TBP, extended TBP and HBM, and the results showed that the TBP model has a better fit than the extended TPB and HBM model. In the TPB model, attitudes and subjective norm has a positive relationship to the seat belt use intention (Şimşekoğluand Lajunen, 2008).

Based on previous findings, this study used the basic framework of TPB to examine pedestrians' violating road-crossing behavior intention regarding attitudes, subjective norms, and perceived behavioral control. In addition to the three basic components of TPB, new factors such as descriptive norms, perceived risk and conformity tendency were tested to assess their influences on the pedestrians' behavior intention.

2. Method

2.1. Questionnaire and survey

Data for this study were collected from the survey. A carefully designed questionnaire was the first step to ensure that the data were reliable and valid for further analysis. The questionnaire for this study consisted of three parts. The first part was the scenario: "You are on your way to school, work or to handle some affairs and you must go to the other side of the road. You reach an intersection and the current pedestrian signal displays red light. You are in a hurry so you take your chance and cross the road in a gap in the traffic." The second part consisted of several questions about the respondents' demographic characteristics like age, gender, educational level, income, etc. followed by the third part focusing on items that were used to assess different constructs of TPB, including the intention to perform the behavior described in the scenario, instrumental attitude, subjective norm, perceived behavioral control, descriptive norm, perceived risk and conformity tendency. The items for each construct are described in the next section.

Prior to the formal survey for this study, a wide range of items in different constructs with a small group of people (35 in total) were tested in order to make sure that each item in the questionnaire was clearly described and easily understood. Cronbach's alpha (α) correlation test and principle component analysis (PCA) were conducted. Only those reliable and valid items through the tests were retained.

The formal survey was conducted in the city center of Dalian, China. Respondents were randomly selected, individually approached, and asked to participate in the study on pedestrians' road-crossing behavior by our interviewers in a public place. Under their agreements, respondents completed a written questionnaire. For those who had difficulty of reading, the interviewers read and explained the questions to them.

A careful examination was conducted for the total of 300 questionnaires collected and the questionnaires with missing data were removed, reducing the number of questionnaires to 260. Among the 260 respondents, the distributions of their age, gender, educational background, income, holding a driver license, and driving frequency were described in Table 1. Descriptive statistics showed that 57.3% of the respondents were female and 42.7% were males. Nearly half of the respondents (49.2%) ranged from 18 to 24 years old and more than one third (33.1%) ranged from 25 to 39. 58.5% had an undergraduate degree, 18.1% finished high school and 12.7% finished middle school. 45.9% received a monthly income 2000–5000 yuan, and 38.1% received less than 2000 yuan. Respondents who had a driver license accounted for 68.1%, but most of them do not drive (78.1%), or rarely drive (9.6%).

2.2. Data reliability and validity

For each construct, the internal consistency of the items should be evaluated for the reliability of the survey data. Cronbach's alpha (α) correlation test was performed. A Cronbach's alpha (α) generally ranges between 0 and 1. The closer it is to 1, the greater the internal consistency of the items in the construct (Nunnally and Bernstein, 1994). Validity of the items was tested

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