Analysis of Pedestrian Violation Behavior Based on Herd Mentality

Cao Yang[1, a], Chen Shuyan[1,b] and Xiao Zhongbin[2,c]

[1] College of southeast university, Department of Transportation, China

[2] Yangzhou university, College of Science and Engineering, China

[a]caoyang@seu.edu.cn, [b] chenshuyan@seu.edu.cn, [c] zbxiao@yzu.edu.cn

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Abstract: For in-depth understanding of the effect mechanism of group crossing violation under the herd mentality, the pedestrian traffic data of typical signalized intersection in Yangzhou were collected by timely psychological inquiry. Then established a model of group conformity violation based on the herd mentality by binomial logistic model, and gave a quantitative analysis of the influence degree of herd mentality on the violation behavior. Finally combining expectancy theory and modeling results, the mechanism of violation behavior based on herd mentality was analyzed, and the corresponding countermeasures were put forward.

Introduction

Pedestrian traffic is an important part of city traffic. Pedestrians, as a "vulnerable group" in the traffic system, are more vulnerable in traffic accidents. According to the data of the ministry of public security of China, the number of casualties and direct economic losses in pedestrian traffic accidents in 2015 accounted for respectively 6.95% and 61.8% of non motor vehicle accidents[1]. The pedestrian traffic accident should not be underestimated. "Chinese style crossing the road" has become the main cause of pedestrian crossing accident. It shows that if there is a person crossing the street illegally during the red light, there will be a lot of people following him. This phenomenon involves many subjects, such as psychology and behavior. To alleviate this phenomenon, it is necessary to analyze the formation mechanism of illegal behavior from a multidisciplinary perspective.

Literature Review

Foreign scholars studied more deeply on characteristics of pedestrian behavior in street crossing. Chu (2002) designed questionnaire to understand the respondents' preference, and used nested logit model to study the behavior of pedestrians crossing the street [2]. The behavioral differences of pedestrians of different ages and genders in dangerous environment were studied by Holland[3, 4]. In terms of influencing factors, Zaki analyzed group crossing behavior from video data [5]. Onelcin analyzed the factors affecting violation behavior such as vehicle position and time gap [6]. The influence of visual environment on pedestrian crossing decision is studied from the aspects of road facilities and pedestrian self expectation by Brémond[7] and Marie[8]. In addition, based on the theory of planned behavior, Barton studied the attitude and perceived behavior control of pedestrians during distraction, which provided the basis for the development of measures[9].

In China, scholars pay more attention to the phenomenon of illegal crossing based on herd mentality recently. Zhou analyzed the law of pedestrians' illegal crossing based on the network theory[10]. Li feng et al. built a model about the behavior recognition process of the subject from the perspective of psychological threshold[11]. Based on the theory of planned behavior, the correlation between different factors and the conformity of pedestrians is obtained by Zhou[12]. Mei used the theory of diffusion and complex networks to establish an analytical model of conformity psychology in violation crossing[13]. Li proposed a collective behavior threshold model, and obtained the critical value of the phase transition of collective action by simulation[14]. Based on evolutionary game theory, Wu studied the pedestrian crossing behavior[15].

In summary, research content of foreign researches is more detailed, in-depth and mainly focuses on the study of human behavior characteristics. Previous studies in China have conducted a simple

statistical analysis from a psychological point of view, and have attempted to analyze them with new models in recent years. But the above researches rarely use data which can directly reflect the psychology of violation, simply speculate by walking rules. This research aimed to address this knowledge gap. Using timely psychology inquiries to collect data, using binary logistic model to analyze various influencing factors, combining with expectation theory, we got the specific countermeasures on illegal crossing behavior based on herd mentality.

Data

We collected data through field surveys. The intersection of jiangyang west road and hanjiang mid road in Yangzhou was chosen as the survey site. Both the two roads are urban main road and the traffic function is strong. The nearby land is mainly for recreation and accommodation which can attract large traffic flow, and has great research value.

On the one hand, the pedestrian characteristics (age, gender, number, etc.), crossing behavior (walking status, is there a car, the number of people crossing illegally etc.) were observed; on the other hand, inquired the psychology of violation (violation of psychological, risk perception, etc.) and so on questions.

After screening to remove invalid data, we obtained 535 valid data, including 331 illegally crossing data. Variable description is shown in Table1.

Table 1. Variable description

	Variable name	pattern	Variable interpretation and assignment
Dependent variable	Illegally crossing	Binary	yes=1；no=0
Independent variable	**Personal attributes** — Age	Order multiple classification	<16=1；16-35=2；35-60=3；>60=4；
	Gender	Binary	male=1；female=2
	The number of people crossing together	Continuous variable	
	Illegally crossing attributes — Psychology of violation	Disordered multiple classification	herd mentality =1；anxious =2；fluke mind =3；unconscious mind =4；
	Danger sense	Ordered multiple classification	level ranges between 1 and 4
	Walking state	Disordered multiple classification	walk=1；walk after run=2；run after walk=3；run=4
	Stop during the walk	Binary	Yes=1；no=0

Methodology

Timely Psychological Inquiry. This is an innovative method adopted in this study, which makes up for the deficiency in some literature that mental data cannot be obtained. The specific approach is: when observing the violation crossing, the observer proceeded to ask violator the questions set by the psychological professional. The questions are implicit, which is easy to be accepted by the violator and can reflect the psychological and security perception of them. Practice found that as long as the investigator has a friendly attitude and asks questions in a more euphemistic way, pedestrians are willing to cooperate with the investigation. This allows the study to grasp more accurately match

between the behavior and psychological data, greatly improving the accuracy and reliability of the research.

Binary Logistic Model. Logistic model is the earliest discrete selection model based on utility theory. In the transportation field, it is often used to analyze the problems related to decision making and choice behavior. At signalized intersection, there are two choices for pedestrian crossing decisions: compliance with regulations and violation of regulations. It is a binary classification variable, binary logistic model are used in this paper.

We view whether or not people illegally crossing as the dependent variable, if it is illegal then y=1; if not, y=0. The formula is as follows:

$$p(y=1)=\frac{1}{1+\exp[-(a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+e)]} \; ; p(y=0)=1-p(y=1) \tag{1}$$

In this formula, a is a constant, b represents the regression coefficients of the logistic model, X_i represents different independent variables, e represents error term.

Results

Logistic Model. The output of the binary logistic model is shown in the table below

Table 2. Binary logistic model output results

Independent variable			output results
Personal attributes	Age	<16	0 reference level
		16-35	0.76 (0.080) *
		35-60	0.12 (0.230)
		> 60	-0.26 (0.491)
	Gender	male	0 reference level
		female	-0.47 (0.793)
	The number of people crossing together	1	0 reference level
		2	0.57 (0.181)
		3	1.07 (0.062) *
		4	1.28 (0.046) **
		>4	1.69 (0.000) ***
Illegally crossing attributes	Psychology of violation	unconscious	0 reference level
		anxious	0.79 (0.076) *
		fluke mind	2.35 (0.000) ***
		herd mentality	3.56 (0.000) ***
	Danger sense	hardly	0 reference level
		a little	0.04 (0.631)
		general	0.29 (0.073) *
		very	0.84 (0.037) **
	Walking state	walk	0 reference level
		walk after run	0.17 (0.573)
		run after walk	-0.21(0.794)
		run	0.42 (0.892)
	Stop during illegally crossing	yes	0 reference level
		no	-0.58 (0.773)
Constant B= 1.463（0.674）; N=535; R^2=0.317; Cox&Snell R^2=0.839; Nagelkerke R^2=0.986; sig value in Hosmer and Lemeshow test=0.569			

*** sig. <1% , ** sig. <5% , * sig. <10%

After the model test, we found that both Cox&Snell R^2 and Nagelkerke R^2 squared are close to 1 and the sig. value in Hosmer and Lemeshow test is 0.569>0.05, so the fitting of the model is good. As

we can see from table 2, three factors: number of people crossing together, psychology of violation and danger sense have a great influence on illegally crossing. Among them, fluke mind and herd mentality are most serious. We use expectation theory to further analyze the results and put forward countermeasures.

Analysis based on Expectation Theory. The most representative theory of expectation theory[16] (Victor Vroom) is that the degree of motivation of a goal is influenced by two factors: the target titer and the expectancy, which is described by the formula:

$$M = V \times E \tag{2}$$

Where M is the level of excitation, indicating the driving force of a certain action ; V is the target titer, is a value judgment of result, main affected by the concept of people. It's usually going to be [- 1, + 1], in this paper, [0, 1] is more advantageous to understand and study. The more important the result is to the individual, the more the value will approach l, or conversely it will be close to zero.

E is a subjective estimate of the likelihood of achieving the target, usually going to be [- 1, + 1]. Only when people think that the likelihood of achieving that goal is very high, they will try to achieve it.

In this study, the driving force of the violation (M_w) has two components: the benefit of illegal behavior (t) and the punishment (f), then:

$$M_w = M_t - M_f \tag{3}$$

According to expectancy Theory:

$$M_f = V_f \times E_f , \ M_t = V_t \times E_t \tag{4}$$

Finally, we can figure out that:

$$M_w = V_t \times E_t - V_f \times E_f \tag{5}$$

Analysis of (5) shows that when the benefit of illegal behavior is greater than the punishment level, there will be illegal behavior, or conversely will contribute to law-abiding behavior. Accordingly, we can put forward corresponding countermeasures against pedestrian violation behavior based on herd mentality. The detailed analysis is shown in table 3:

Table 3. The analysis of driving force and measures about illegally crossing

The object	Measure	Embodies the measure
benefit of illegal behavior	decrease driving force	Danger perception education, accident damage education, traffic law publicity
punishment	increase driving force	Equipped with traffic police and voluntary, exposure and fine

We can start from two aspects to reduce the behavior of crossing the street illegally based on herd mentality.

1) Reduce the benefits of illegal behavior. Pay attention to risk awareness education; carry out lectures on traffic knowledge in schools; use modern media to increase traffic accident education and traffic law propaganda.

2) Increase external punishment. Equipped with traffic police at the intersection and recruited volunteers to assist the management. At the same time, the violations shall be exposed and fined. Use a variety of punishment education means, such as increasing the amount of fine, recording the violation record for personal credit system reference, etc. Of course, all kinds of punishment measures should combine the actual situation of the local.

Conclusions

This paper studied the behavior of pedestrian illegally crossing under the influence of herd mentality. The method of timely psychological inquiry was adopted to collect data that can directly reflect the illegal psychology. Binomial logistic model was established to make quantitative analysis of the influence degree of different variables. Among them, herd mentality and fluke mind are of the most influence. Finally using expectancy theory to analysis modeling results, it is concluded that reducing benefit of illegal behavior and increasing punishment are effective countermeasures.

The research idea of this paper applies to other general signalized intersections. The logistic modeling results can provide the basis for quantitative analysis of the incentive level in the expectation theory. Combine these two methods can help decision makers make more targeted and effective countermeasures

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