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A Review of Pedestrian Crossing Research Based on Traffic Behavior

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Abstract

Pedestrian traffic is an important part of urban road traffic, and has a significant impact on the safety, order and smooth flow of the entire transport system. This paper conducts a more comprehensive research on the psychology and traffic behavior of pedestrians crossing the street, introduces the current state of research at home and abroad, and analyses the main characteristics of pedestrian crossing traffic behavior, and finally combines the analysis of the characteristics to give a few measures for pedestrians crossing the street.

Keywords

Pedestrian crossing, traffic behavior, behavioural characteristics.

1. Introduction

Walking is one of the modes of transportation that people choose to travel, and it is also an important component of urban transportation. In the urban road system, motor vehicle traffic, as the main body of traffic, has received widespread attention, while pedestrian traffic lacks due research.

In addition, as a vulnerable group of urban traffic, pedestrian traffic also needs to be paid more attention. On the one hand, because pedestrians are directly exposed to the traffic environment, they usually do not have any safety protection facilities to prevent them from happening, and they are the most vulnerable travelers. On the other hand, people's traffic behavior is very flexible, and in the absence of management, illegal behaviors such as rushing the road and running red lights are more likely to occur, thereby causing various traffic accidents and bringing more problems to traffic management.

Among pedestrian traffic facilities, pedestrian crossing facilities are the most important factor affecting traffic safety and order. Traffic conflicts between pedestrians, cars and non-motor vehicles are very serious. The planning, design and management of such facilities require pedestrians More in-depth research on traffic psychology and traffic behavior is the core problem that needs to be solved. In view of the above situation, through a comprehensive study of the pedestrian crossing traffic psychology and traffic behavior, the main characteristics of the pedestrian crossing behavior are analyzed to provide support for the planning and design of traffic facilities.

2. Research status of pedestrian crossing

In 2018, the World Health Organization published the Global Status Report on Road Safety 2018[1]. The report shows that road traffic fatalities are on the rise every year worldwide, with one road traffic fatality every 24 s and 1.35 million road traffic deaths per year, of which 26% are pedestrians and cyclists. Therefore, how to reduce the rate of traffic accidents has become one of the most important issues studied by the traffic authorities.

2.1. Current status of foreign research

In recent years, there are many foreign literatures on the study of pedestrian crossing characteristics. APTOULA E[2] suggested to use delay analysis to study the flow law of two-way pedestrians on crosswalks, and to study the waiting time of pedestrians; GUOR Y[3] studied people traveling across the street. According to the pedestrian crossing model and safety standards at the time, and through numerical simulation of pedestrian arrival interval and safety factor to achieve impact analysis on pedestrian delay; OJO T[4] assesses the behaviour and safety of pedestrians at pedestrian crossings based on studies of urban travelling pedestrians by using raw and survey-based data.

2.2. Current status of domestic research

In addition, there are many domestic researches on pedestrian crossing. Zheng Changjiang[5] calculated the pedestrian crossing time according to the traffic characteristics of pedestrians in the no-signal control of urban streets, and studied the pedestrian crossing time through VISSIM simulation; Wang Zhixiang [6] Based on the principles of traffic psychology, by studying the traffic behavior of pedestrians, the traffic behavior of pedestrians crossing the street at each intersection is analyzed, and the countermeasures to improve the safety of pedestrians crossing the road are proposed; Wu Lixin[7] studies when crossing the crosswalk under the control of no signal lights at the entrance and exit of the university. According to the intersection situation, Pei Yulong[8] proposed a delay model for crossing the city without control signals, and the results show that it can be applied to calculate the delay situation; Pei Yulong[8] passed the intersection, traffic volume and road Distribution etc. to study the risk of crosswalks in person. Previous crosswalk studies have focused on pattern and behavior classification, time-delay, and VISSIM simulations of crosswalks, and since they do not take into account the subjective factors of pedestrians' inclinations, they cannot accurately reflect the intersection characteristics of different types of crosswalks.

Sun Di et al.[9] analyzed the main influencing factors of gait behavior by using trajectories, surveyed data, collected the spatiotemporal trajectory curve process at pedestrian crossings and the characteristics of gait behavior changes, analyzed the key influencing factors of pedestrian behavior, and the interference of static factors. Effects can also improve and strengthen existing models of social power by adding parameters such as angle to reflect the influence of factors on behavior. Finally, a model for determining gait behavior influenced by overall factors is developed based on the principles of force building.

Shi Jiangwei[10] focuses on crossings, pedestrian crossings as observation points, methods and processes of pedestrian crossings and pedestrian walkways, and the characteristics of pedestrian crossings through local monitoring. It analyses four aspects of traffic engineering, the installation and control of crosswalk facilities and the investigation and monitoring, and proposes an improvement plan.

3. Analysis of pedestrian crossing characteristics

3.1. Psychological characteristics

In the whole urban traffic system, taking people as traffic objects has a certain degree of subjectivity and initiative. In general, vehicles, roads and their ancillary facilities must cooperate to meet the needs of traffic actions. For pedestrians crossing a crosswalk at an intersection, the main need most pedestrians consider is safety requirements, and other requirements for ease and comfort of crossing the road are not considered when safety is guaranteed. The process of pedestrians crossing the street in a general signal intersection includes four processes: the arrival stage, the judgment stage, the waiting stage and the action stage. When pedestrians arrive near a zebra crossing at an intersection, they need to check the

surrounding traffic conditions, such as whether the traffic lights show green traffic lights, the length of the zebra crossing, the number of people around, and the number of vehicles passing through. If it is found that it is impossible to pass after observation, that is, pedestrians do not have the right of way, at this time either wait for the signal to change, or decide to forcibly pass. Before breaking the rules, pedestrians should carefully consider the surrounding traffic situation, which requires a decision based on the pedestrian's psychological behavioral characteristics.

Zhang Jingbin et al. [11] and Sun Zhiyong et al. [12] investigated that the psychological characteristics of pedestrians on crosswalks may be different. According to the differences in psychological behavior characteristics, pedestrians are divided into the following types: (1) stable pedestrians, these pedestrians can strictly abide by the traffic rules when crossing the road without violating the rules; (2) unstable people, these pedestrians In the process of crossing the road, they will show different behaviors but also obey the rules, but in most cases, they cross the road with "ideas"; (3) the group-dependent pedestrian, who crosses the road involuntarily, shifting more attention to those around him and deciding whether or not to cross based on whether or not those around him are crossing, with little autonomy; (4) the anti-conventional pedestrian, who, unlike the general population, believes that he is crossing in compliance with the rules, when in reality he is not.

Zhang Guoqiang et al.[13] found through the psychological analysis of pedestrian crossing traffic that in terms of the acceptable detour distance for pedestrians crossing the street, people in different regions and countries have very significant differences in the acceptable detour distance. If the distance is too long and exceeds the psychological limit of pedestrians, pedestrians will tend to choose to cross the street directly in violation of traffic rules. Usually, in the process of waiting to cross the street, the patience of pedestrians will gradually deteriorate over time. When the waiting time exceeds the tolerance limit, pedestrians will directly cross the street regardless of the traffic rules, which will affect the traffic order of urban roads. However, there is no unified conclusion on the tolerable waiting time, and further research is needed.

In this study by Guo Cunlu et al.[15], the psychological characteristics of pedestrians during the peak period of no signal control are obvious, and the pressure of pedestrians when crossing the road reflects the psychological characteristics of various types of pedestrians at different speeds.

3.2. Behavioral characteristics

The characteristics of pedestrian crossing behavior mainly refer to the characteristics of pedestrian crossing speed, which is related to whether the intersection is signal-controlled, the age and gender of pedestrians, and the purpose of travel.

3.2.1 Survey method

Shi Jiangwei[10] selected two T-shaped intersections as the survey sites, and used the manual survey method to select three different age groups, namely the elderly, young men and young women, to investigate their crossing characteristics.

Chen Jun[16] investigated and analyzed the speed characteristics of pedestrian crossings at signal-controlled intersections. Among the pedestrian traffic survey methods, manual survey methods and automatic instrument detection methods are mainly used. UAV aerial photography was used to design the experimental procedure based on the video survey method to obtain the required data. By analyzing the traffic behavior parameters of the crosswalk using Adobe After Effects and Simi Motion software, the data obtained became the basis for the study of pedestrian traffic behavior and crosswalk modeling.

Guo Cunlu et al.[15] in the study of pedestrian crossing behavior, through the investigation of the early pedestrian crossing behavior trends at pedestrian crossings, to grasp the pedestrian

behavior trends. Three pedestrian crossings were selected to investigate trends in pedestrian traffic behavior by age, questionnaires were conducted, and surveys were conducted for 10 consecutive days to obtain accurate data. The questionnaire is mainly based on the normal emotional responses of pedestrians when crossing the road. Pedestrians face risks, delays, pressures, and intersection spacing when crossing the road. Pedestrians' behavioral tendency to cross the road is qualitatively determined by the standards of pedestrians' psychological behavioral characteristics and social laws.

3.2.2 Behavioral Characteristics Analysis

Shi Jiangwei[10] can summarize some traffic behavior characteristics of young people crossing the street by analyzing the collected data and combining with field investigation:

(1) The stride of young men is slightly larger, but the frequency is slightly smaller. This is because young men have more energy, stronger bodies, faster reaction times, and more confidence in themselves. In addition, compared with female travelers, young men can make corresponding judgments more quickly when faced with emergencies. But at the same time, the risk-taking mentality of young men is more likely to put men at risk.

(2) The young women's stride is slightly smaller, but the frequency is slightly larger. Young women usually travel with companions, and women are more likely to cross the road in groups. On the one hand, motor vehicles are easier to detect and alert to a large number of people crossing the road. On the other hand, young women are more comfortable crossing the road in a crowd. At the same time, if there is a vehicle approaching across the road, the young women generally choose to retreat, while the young men choose to speed up to pass.

(3) The stride and cadence of young people are larger than those of the elderly, mainly due to reasons of physical function, and the elderly generally go out for walks, grocery shopping, etc., there is no urgent matter, and they are more leisurely. And young people generally need to go to work or go to school, and they are in a hurry, which leads to this difference.

It can be seen from the actual data based on the relevant literature that the pedestrian crossing speed of 13-19-year-old pedestrians is 2.7m/s during the green light time of a cycle, the crossing speed of 20-49-year-old pedestrians is 1.8m/s, and the pedestrian crossing speed of pedestrians over 50 years old is 1.8m/s. The pedestrian crossing speed is 1.5m/s, but when pedestrians illegally pass the crosswalk at the intersection, the pedestrian flow and the traffic flow will interfere with each other, and the pedestrian crossing speed will be affected accordingly. When pedestrians cross the sidewalk through the traffic flow, there is a difference compared with passing the intersection without any scruples in the green light state. In this case, when the pedestrian is relatively safe at first, the pedestrian crossing speed will gradually increase and finally pass the pedestrian crossing quickly[14].

Guo Cunlu et al.[15] analyzed the crossing behaviors with different traffic behavior trends, and showed that the pedestrians with dominant behavior tended to have the least aversion to the crossing delays of the crosswalk and the street. When the safety interval is reached, it will choose to pass, not afraid of danger, and speed up the passage with the motor vehicle. Pedestrians with influence-oriented behavior tend not to lose time when crossing the road and are more optimistic. Wait for a good moment to pass this section. During rush hours, cross the road and cars at low speed, and choose to wait on the marked line if there is a vehicle in the current lane. Pedestrians with thinking behavior tend to have a larger delay value when crossing the street, and they will choose to cross the road in the crowd. When crossing alone, consider traffic in the lane ahead and intersections, safe speeds and distances to stay safe. If you can't pass, we will wait patiently. Pedestrians who tend to behave conservatively tend to delay crossing the crosswalk the most and do not want to rush crossing the crosswalk. If there is heavy traffic during peak hours, it will let the driver go first and wait for the opportunity to cross the road. The above is an analysis of the characteristics of the four types of pedestrians.

Chen Jun[16] analyzed the free speed of pedestrians crossing the road. When pedestrians crossed the road, observe the motion state and surrounding environment of each pedestrian, and determine that the pedestrian is in a free walking state. In terms of gender, it is found that the average free speed of male pedestrians is 1.43 m/s, the average free speed of female pedestrians is 1.3 m/s, and the free speed of male pedestrians is higher than that of females. There is a slight difference between the minimum and maximum free speeds for males and females. The standard deviation of free velocities for males is smaller than that for females, indicating that the distribution of male free velocities is more concentrated. The analysis of the data collected for different age groups shows that the average free speed of young and middle-aged pedestrians crossing the street is 1.39m/s, which is significantly higher than the 1.02m/s of the elderly. It can be seen from the figure that the peak free movement speed of the elderly is close to 25% of the speed of young and middle-aged people, so it can be seen that there is a significant difference in the free movement speed of the two. From the above analysis, it can be seen that there are significant differences in free running speed according to two factors, gender and age.

4. Measures

4.1. Measures to improve the safety of pedestrians crossing the street

(1)Install monitoring equipment on pedestrian crossing sections, and use outdoor LED screens to expose the dangerous crossing behaviors of pedestrians with dominant and influential behaviors and mixed crossings[15], and strengthen traffic safety education for pedestrians crossing the street.

(2) Install an infrared thermal imaging non-destructive testing device to detect pedestrians waiting to cross the street. When the pedestrian waiting time exceeds the threshold, the voice broadcast prompter will be turned on[15]. At the same time, the electronic screen of the driving lane will prompt pedestrians to cross the street, slow down and be courteous, which is helpful for thinking , Steady behaviors tend to pedestrians cross the street safely.

4.2. Measures to reduce pedestrian violations

Pedestrians are the main players in the urban road traffic system, and good pedestrian traffic management plays an important role in the efficient operation of intersections. In this paper, combined with the psychological and behavioral characteristics of pedestrian violations, measures to improve pedestrian violations will be proposed:

(1) In daily life, videos about traffic safety and traffic laws and other knowledge can be released through the media on mobile phones, which can be disseminated in various forms; traffic awareness, which can reduce the accident rate to a certain extent.

(2) Set up pedestrian crossing facilities according to the actual intersection situation. At large intersections, pedestrian bridges or underground passages can be built to reduce the communication between pedestrians and motor vehicles, and accidents can be avoided to a large extent; pedestrian crossing lights can also be set up, and certain slogans can be configured to make drivers pass the pedestrian crossing. Ability to reduce speed or stop to yield.

(3) When pedestrians and motor vehicles are chaotic at intersections, it is necessary to formulate good traffic rules and ensure that pedestrians and drivers can abide by them to a large extent; signal timing should be set according to the actual traffic volume of the intersection. This reduces collisions between vehicles and pedestrians inside the intersection.

(4) Traffic police can be set up in areas with large traffic flow to maintain order and ensure the passage of this road section. Especially in some scenic spots or holidays, it is more necessary for certain personnel to maintain the traffic order.

(5) It is also necessary to pay attention to the travel and management of the elderly and children among the traveling crowd.

5. Conclusion

As a vulnerable group in urban traffic, the psychology and behavior of pedestrians in using traffic facilities has a very important impact on the safety, orderliness and smooth flow of traffic, and more in-depth and systematic research is needed to better guide the development of traffic engineering theory and practice.

This paper makes a preliminary discussion on the current situation of pedestrians crossing the street, analyzes the characteristics of pedestrians' traffic psychology and traffic behavior in the process of crossing the street, and briefly proposes some solutions for pedestrians crossing the street. Due to my limited ability, I have not carried out in-depth development of many problems. I hope to make breakthroughs in the research on pedestrian crossing traffic behavior in the future.

References

[1] Zhang Yali.World Health Organization releases Global Status Report on Road Safety 2018[J].Chinese Disaster Relief Medicine,2019,7(2).

[2] APTOULA E, LEFEVRE S. On lexicographical ordering in multivariate mathematical morphology[J]. Pattern Recognition Letters,2008,29(2):109-118.

[3] GUO R Y. Interactions between Pedestrians Crossing and Vehicles on Roads[C]//2011 Fourth International Joint Conference on Computational Sciences and Optimization.[S.I.]:IEEE,2011.1104-1108.

[4] OJO T,ADETONA C, AGYEMANG W, et al. Pedestrian risky behavior and safety at zebra crossings in a Ghanaian metropolitan area.[J].Traffic injury prevention,2019,20(2): 216-219.

[5] Zheng Changjiang, Liu Feng,Huang Xiaodi.Research on pedestrian crossing time at pedestrian crossings without signal control[J].Journal of Wuhan University of Technology,2012,36(3):475-478.

[6] Wang Z.C., Yang N. ,Li Z.G.Research on pedestrian crossing behavior based on traffic psychology[J]. Automotive practical technology,2017(15): 3-5.

[7] Wu Lixin, Wang Peng. Research on pedestrian crossing delays on unlit sections at entrances and exits of high schools[J].Transportation Technology and Economy, 2019, 21(1):6-9; 27.

[8] Sun Chongjing. Risk assessment of pedestrian-right-turning vehicle conflicts at urban intersections [J].Traffic and Transportation,2018(z2):64-67.

[9] Sun Di, Fang Jianjun,Gao Xueying,Gao Zongyu.Analysis of pedestrian behavior of street crossing based on virtual force[J].Highway Traffic Technology,2015,32.

[10] Shi Jiangwei. Research on pedestrian crossing behavior at intersections[J]. Automotive practical technology,2018,19.

[11] ZHANG VIP, LI MINGHUI, ZHAO JINFENG et al. Analysis of pedestrian crossing needs[J].Road Traffic and Safety,2007(6):26-29.

[12] Sun ZY, Rong J,He Met al.Study on acceptable clearance for pedestrians at signalized crossings 121[J].Highway Traffic Technology,2004(11):102-113.

[13] Zhang Guoqiang, Wang Skun.Analysis of pedestrian crossing traffic psychology and traffic behavior[J].Journal of Southeast University(Philosophy and Social Science Edition),2019,12.

[14] Li Xinghua. Analysis of pedestrian traffic characteristics at intersections [J]. Engineering Science and Technology,258.

[15] Guo Cunlu, Zhang Jinglei,Li Mengqi,Chen Ci.Analysis of pedestrian crossing characteristics based on traffic behavior[J].Traffic and Transportation,2020,36.

[16] Chen Jun. Characterization and Modeling of Pedestrian Crossing Traffic Behavior at Signal-Controlled Intersections[D]. Xi'an:Chang'an University.2017.

[17] Jie Zhang. Analysis of Pedestrian Traffic Characteristics at Signal-Controlled Intersections[D].Xi'an: Chang'an University.2014.

[18] Zeng S., Wu Y. M., Ye J. B., et al. Analysis of pedestrian crossing behavior and psychological characteristics on unsignalized road sections[J].Journal of Foshan Institute of Science and Technology(Natural Science Edition),2016,34(5).

[19] An L. Y., Wu S. Y., He Y. M.. Research on the design of non-contact pedestrian crossing signal system[J].Shanxi Architecture,2021,47(08).

[20] TAO W.ZHAO J,LI c Y. Pedestrian delay model for continuous flow intersections under three desig patterns[J].Mathematical Problems in Engineering,2019,2019.

[21] Dai Zhongxiang. The influence of psychological factors on pedestrians' safe street crossing behavior[J]. Smart City,2019,5(20).

[22] YANG Xiaodong, LIU Xiu,XIE Siyuan,et al.Signal detection-based safety device for pedestrian crossing[J].Shanxi Architecture,2019,45(13).

[23] Yan Xidong, Wang Yunxia. Traffic safety problems of pedestrian crossing on road sections and suggestions for improvement[J].China Public Safety: Academic Edition,2019(2).

[24] Li L,Lei Xianhua, Hu Xiangyan.Research on traffic safety of pedestrians crossing streets affected by right-turning vehicles[J].Think Tank Times,2019(11).

[25] Ma G.H.; He R., Zheng C.J.,et al. Research on the optimization method of roundabout intersection timing considering pedestrian crossing factors[J].Journal of East China Jiaotong University, 2019,36(1).

[26] Yin Yan, Cao Changjian, Li Jing, et al. Research on the safety impact of different types of pedestrian signals on pedestrians crossing the street[J].Traffic Standardization,2014(3).