Study on Aggressive Driving Activities at Crossroads in Beijing

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Abstract. The objective of this study is to explore the influence of aggressive driving activities on microscopic traffic flow at crossroads in Beijing. Thus, we performed observations and corresponding statistical analysis to present some of the features. The results indicate that the number of occupying the bus lane and jumping the queue in the period of rush-hour is higher distinctly than those in the period off-peak. And the aggressive behaviors do not only block the microscopic traffic flow, but facilitate the vehicles crossing the crossroads quickly.

Keywords: aggressive driving activities, crossroads.

1 Introduction

The problem of aggressive driving has become a major concern in China. Many studies have indicated an association between aggressive driving and increased risk of automotive vehicle accidents [1], [2], [3], [4]. For aggressive driving, U.S. National Highway and Traffic Safety Administration (NHTSA) defined it as the operation of a motor vehicle in a manner, which make people or property being dangerous or likely to dangerous [5]. Tasca [6] thought that aggressive driving behavior should be "if it is deliberate, likely to increase the risk of collision and is motivated by impatience, annoyance, hostility and/or an attempt to save time." Generally, aggressive driving activities include: speed, tailgate, fail to yield, weave in and out of traffic, pass on the right, make improper and unsafe lane changes, run stop signs and red lights, make hand and facial gestures, scream, honk and flash their lights [5], [7], [8].

Although many academic studies focus on the psychological perspective, factors contributing to aggressive driving such as situation conditions; personality factors; and demographic background variables [9], [10], [11], [12], [13], [14], [15], [16], aggressive driving still remain largely unknown such as effects of aggressive driving on load capacity. Thus, in this paper, we will observe aggressive driving activities at a crossroad in China and try to summarize some important features that previous research did not address clearly. The aim is to explore the influence of aggressive driving on microscopic traffic flow at crossroads in Beijing and the relationship

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between aggressive driving and traffic congestion will be observed. Are there more aggressive driving activities while the traffic is more congested? And reversely, how degree does the aggressive driving influence the microscopic traffic flow?

2 Methodology

If drivers are in impatience, annoyance, hostility or urgency, their driving behaviors will be likely to increase the risk of collision [6]. These behaviors are described as aggressive driving activities. In Beijing, three kinds of aggressive driving behaviors were common, which were occupying a bus lane, weaving in and out of traffic and jumping a queue. Therefore, in this study the behaviors were observed and recorded. The three kinds of activities are described specifically as follows.

- Occupying bus lanes. A bus lane in Beijing is a lane restricted to buses on rush-hour time in a day, which is used to speed up public transport. Consequently, while other lanes are congested, the bus lanes are often unobstructed. So, some private cars often occupy the bus lanes in order to save time in rush-hour time.
- Weaving in and out of traffic. Out of personality, driving habits, or saving time, some drivers change lanes more frequently or cut across multiple lanes. For example, change to another lane from this lane and immediately return to this lane while there is an empty section and change constantly in the course of driving, or change across multiple lanes in a time.
- Jumping the queue. This is the act of entering a queue or line at the front other than the current position. Especially at crossroads, the drivers would change into the empty lane while the current lane is congested many vehicles. And near the crossing, the drivers cut in too close in front of vehicle.

Fig. 1. The observed crossroad in Beijing, China

This study observed aggressive driving activities at a crossroad near the 2rd-Ring in Beijing (see the Fig. 1). The observer was located on the overpass at the crossroad. The section observed included the crossroad and near 200 meters road of one direction. The observation was conducted and recorded by a video camera in Sept. 15th-21st, 2012. In this week, we recorded the traffic situation in three periods, which are 7:00-7:30am, 10:30-11:00am, and 5:30-6:00pm. The three periods represent respectively morning rush-hour, off peak, and evening rush-hour.

3 Results

With the observation and statistical analysis, we could figure out the relationship between aggressive driving and traffic congestion and verify traffic load of the lane significantly.

3.1 Observation 1: Statistical Results of Aggressive Driving Activities at a Crossroad

In this study, the actual data of aggressive driving activities at the crossroads were collected. Through observation and analysis of one crossroad in Beijing, we found that the main aggressive driving activities at crossroads are weaving in and out of traffic, jumping the queue, and occupying the bus lane. The following tables (Table1 to table 3) present the number of the three kinds of aggressive driving activities in the different periods in a day representing rush hour and off peak. In the table 4, the basic statistic results including mean and deviation of the number of three kinds of activities are shown. In order to test that the number of aggressive activities in the different period of time is significantly different, ANOVA tests are conducted. Table 5-7 present the results. Through the result of ANOVA for occupying the bus lane and jumping the queue, we find that the p-value for significance is less than 0.05. The result indicates that means of the number of the activities from different periods are different significantly. For weaving in and out traffic, we find that the p-value for significance is 0.61 more than 0.05. The result indicates that means of the number of the activity from different periods are not different significantly.

Table 1. Number of aggressive driving activities in the morning

Aggressive activities	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Occupying the bus lane	0	12	7	18	19	19	1
Weaving in and out of traffic	65	159	150	160	157	157	89
Jumping the queue	38	106	114	133	122	89	29

Table 2. Number of aggressive driving activities at noon

Aggressive activities	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Occupying the bus lane	3	2	0	4	5	8	2
Weaving in and out of traffic	107	136	139	168	164	141	102
Jumping the queue	47	48	68	65	72	63	34

Table 3. Number of aggressive driving activities at nightfall

Aggressive activities	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Occupying the bus lane	1	2	1	4	7	12	5
Weaving in and out of traffic	75	108	64	111	125	102	114
Jumping the queue	30	50	29	76	79	44	58

Table 4. Descriptive

Period	Occupying the bus lane		Weaving in and out of traffic		Jumping the queue	
	Mean	Dev.	Mean	Dev.	Mean	Dev.
At morning	10.9	8.3	133.9	39.6	90.1	41.1
At noon	3.4	2.6	136.7	25.3	56.7	13.9
At nightfall	4.6	4.0	99.9	22.1	52.3	20.1
Total	6.3	6.2	123.5	33.2	66.4	31.4

Table 5. ANOVA (Occupying the bus line)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	224.000	2	112.000	3.677	.046
Within Groups	548.286	18	30.460		
Total	772.286	20			

Table 6. ANOVA (Weaving in and out of traffic)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5886.095	2	2943.048	3.277	.061
Within Groups	16167.143	18	898.175		
Total	22053.238	20			

Table 7. ANOVA (Jumping the queue)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5997.238	2	2998.619	3.938	.038
Within Groups	13707.714	18	761.540		
Total	19704.952	20			

3.2 Observation 2: Loads of Aggressive Driving

As stated above, aggressive driving activities at the crossroad were observed and calculated. Based on the data, then we analyze the influence of the aggressive driving on the microscopic traffic flow. Firstly, we observed and analyze the videos of the crossroad. Then, we counted the number of vehicles that passed during the 10 seconds right after the signal changed red to green.

Motor vehicles can drive at normal speed passing the crossroad unless some other aggressive driving vehicles blocking them. So, firstly we assume that the load of the motor vehicle without aggressive driving is one and the other one is the load with aggressive driving while passing the crossroad. With the assumption, the average number of the vehicles that can pass in a period of green light when there are no aggressive driving activities is calculated. This is average load capacity (ALC). Table 8 is the descriptive statistics we computed ALC from the data.

Table 8. Descriptive for ALC

N	Minimum	Maximum	Mean	Std. Deviation
150	2	6	4.6	.7

While there is aggressive driving at crossroads, the number of vehicles passing is reduced. The reduction in number is caused by the aggressive driving activities. The below formula (1) is displayed for it. When we applied the formula (1) with ALC (4.6), we could obtain Table 9. According to the results, the aggressive driving load (ADL), 0.33, is 67% less than no aggressive driving load (ALC), 1. That is to say, we

considered that the ADL would be larger than the ALC, but the ADL is relative small. Therefore, the aggressive driving activities do not block the microscopic traffic flow in terms of the calculation.

$$Aggressive\ driving\ load(ADL) = \frac{\mathrm{ALC} - number\ of\ vehicles\ \ exculding\ aggressive\ driving\ ones}{number\ of\ aggressive\ driving\ vehicles}$$

Table 9. Descriptive for ADL

N	Minimum	Maximum	Mean	Std. Deviation
34	-1.4	1.6	0.33	.62

4 Discussion and Conclusion

Although the problems of aggressive driving and traffic jams have become major concerns in China, especially in Beijing, few of papers study the relationship between aggressive driving and traffic congestion will be observe. Therefore, the aim of this study is to explore the influence of aggressive driving on microscopic traffic flow at crossroads in Beijing. Thus, we performed observations and corresponding statistical analysis to present some of the features.

First, for the behaviors, occupying the bus lane and jumping the queue, the differences between means of morning rush-hour, off-peak, and nightfall rush-hour are significant. Therefore, the number of occupying the bus lane or jumping the queue in the period of rush-hour is higher distinctly than those in the period off-peak. That is, in order to save time drivers occupy the bus lane and jump the queue in the period of rush-hour, especially in the morning much more than in the period of off-peak. Actually, the early positions before stop lines become scarce resource at time of traffic jam. So, through occupying public resource or private resource these drivers take early position. Second, for the behavior, weaving in and out of traffic, the difference between means of morning rush-hour, off-peak, and nightfall rush-hour is not significant. So, we could not consider that the number of weaving in and out of traffic in the period of rush-hour is higher distinctly than those in the period off-peak. But, the absolute amount of the behavior is relative large comparing with the other two kind behaviors. That is to say, no matter whether the traffic is in congestion, the drivers like to change the lanes casually in the process of driving. In addition, the number of occupying the bus lanes is relative fewer than that of the other two kinds of behaviors.

We assumed that aggressive driving activities would block the transportation at crossroads because the activities influence other drivers' driving efficient. But, through the calculating the ADL, we found the aggressive behaviors did not only block the microscopic traffic flow, but also facilitate the vehicles crossing the

crossroads quickly. Although, some studies found that the aggressive behaviors influenced driver safety, this study discovered that the aggressive activities did not affect the efficient in transportation at crossroads. However, it should be noted that ADL's standard deviation is relative large, so further data collection should be done to make this result more credible.

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