

## Understanding Road Rage: Insights from a Synthesis of Research

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### ABSTRACT

Road rage has been a serious problem and is worthy being paid attention by drivers, road managers, and researchers. This paper aims at providing a general overview of four research methods commonly used. The study covers the definition of road rage, introduction, and evaluation of four research methods. It concludes that the questionnaire survey method is applicable to the studies on impacts of different variables including demographic parameters of drivers. Driving simulating method mainly focuses on the driving behavior in specific driving scenarios. Case analysis method can provide researchers with a better understanding of the certain pattern of road rage. Field experiment method concentrates on target factors by designing suitable field experiments. It is revealed that different research methods have their own applicable conditions and proprieties. Consequently, a suitable research method according to the research objective and the research capability is proposed for the road rage studies.

**KEYWORDS:** Road rage; Questionnaire survey; Driving simulating; Case analysis; Field experiment

## 1. INTRODUCTION

### 1.1. Background

More than 1.2 million people die because of road accidents every year and over 20 million people are injured or disabled by traffic crashes (WHO, 2004). Additionally, 90 percent of the accidents are due to human errors, such as drunk driving, over speed driving, careless driving and road rage (LEWIN, 1982). Road rage is usually referred to aggressive or angry driving behaviors, thus it has significant impacts on road safety. Such behaviors might include rude gestures, verbal insults, physical altercation, deliberately driving in an unsafe or threatening manner, or making threats. Road rage can lead to altercations, assaults, and collisions that result in injuries and even deaths, which can be thought as an extreme case of aggressive driving. These behaviors might cause terrible harms to both the driver himself and surrounding vehicles.

Previous studies have adopted multiple methods to research road rage. Questionnaire is the most widely used method to identify the cause of road rage. Wickens et al. (2015) used the questionnaire to clarify whether gender and childhood experience would make a great impact on road rage. Sârbescu, Stanojević, and Jovanović (2014) conducted a research on whether different

cultures will affect road rage by sending questionnaires to participants' home in Serbia and Romania. Driving simulation is another effective method to analyze driving behavior, because driving scenarios can easily be set and driver's actions can be accurately recorded. Gidron, Slor, Toderas, Herz, and Friedman (2015b) employed the results of indirect measure and simulated driving to support the effectiveness of each other. They simulated the social pressure condition and measured driving behavior indices. It was found out that psychological inoculation reduces road rage behaviors and accidents. Some researchers adopted the road experiment to collect the data of road rage. Shinar and Compton (2004) conducted a road observational study of aggressive driving behaviors. They recorded the frequency of dangerous driving behaviors, such as cutting across a single lane, through honking, and behaviors of cutting across multiple lanes and passing on the shoulders.

## 1.2. Definition of Road Rage

Statistics show that incidents resulted from road rage is said to have increased 51% from 1990 to 1996 (Vest, Cohen, & Tharp, 1997). Road rage will often cause negative results including damage of property, injury, and death, which have a posed great threat to road safety. Meanwhile, research on road rage is extensive but disordered because of the misuse of the term in this field. For example, road rage include aggressive driving and dangerous driving. After typing these three terms in the search engine, it can be found that many items in the outcome lists are crossed and redundant, which have brought much troubles for the traffic safety researchers (Dula & Geller, 2003). According to James and Nahl (2000), aggressive driving is referred to driving with impaired emotions, which will result in behavior that imposes the driver's driving risk on others. Tasca (2000) defined the aggressive driving as an aggressive and deliberate driving behavior, which is motivated by the driver's impatience and hostility and will finally increase the possibility of collisions. Aggressive driving defined in Mizell (1997)'s research is described as an aggressive or impatient motorist or passenger deliberately harming other motorists or driving his or her car into a building. Injury on other road users physically and psychologically is defined as driver aggression in (Lajunen, Parker, & Stradling, 1998) and (Ellison-Potter, Bell, & Deffenbacher, 2001) 's research.

It is significant to generate a unified term and definition that can be used consistently for the further research in the aggressive driving field because using consistent and clear definition will insure the precision in communicating the findings for the traffic safety researchers (Dula & Geller, 2003). Although a consistent term is needed in this field, it is hard to change the using preference of road safety researchers and in this review, road rage covers aggressive driving and dangerous driving.

After summarizing the literatures, driving behaviors which are labeled road rage have the following three features: (a) intentional acts to other road users physically and psychologically; (b) driving with negative emotion; (c) risky driving behavior. It can be declared that if any one of the properties is appeared during the driving process, it can be assumed to be road rage. To sum up, aggressive driving is a behavior shown up in driving process because of angry emotions and is intended to do harm to any road users physically and psychologically.

## 1.3. Research Objectives and Innovation

This review divides the current research methods into several categories and then evaluates the feasibility of them. In a brief summary, the research methods that have been used in the past include the questionnaire survey method, driving simulation method, case analysis method and

field experiment method. It is a brand-new angle which is needed for the current research in aggressive driving area because of the extensive and mixed research results in this field.

## 2. QUESTIONNAIRE SURVEY METHOD

### 2.1. Driving Anger Inventory

To describe the level of giving anger, several scales are designed for evaluating road rage. The scales could be used to design questionnaire, and the anger level will be achieved from distributive questionnaire. The following chapters will introduce three classical scales, namely, DAX, DAS, PADS about their functions and generating process.

#### 2.1.1. Driving Anger Expression Inventory

Jerry L. Deffenbacher, Lynch, Oetting, and Swaim (2002) developed Driving Anger Expression Inventory (DAX). DAX evaluates driving anger with people's driving behaviors. When driver acts different angry expression forms, it could reveal different anger levels of drivers. 290 introductory psychology students participated in this research, including 82 men and 182 women (26 are missing data). The participants were asked to recall the way that they or other people express anger during their driving experience in the past one year, and these expressing ways were ranked 4 levels according to frequency of rage driving behaviors. Researchers summarized all the behaviors into DAX, which contains 62 items about the way of people expressing their angry during driving. The 62 items could be classified into four ways: *Verbal Aggressive Expression*, *Personal Physical Aggressive Expression*, *Use of the Vehicle to Express Anger* and *Adaptive/Constructive Expression*.

The DAX inventory is applied into different researches. Sullman, Stephens, and Yong (2015) adopted 49-items survey which based on the DAX inventory to test whether DAX could apply to Malaysia area. The result showed that the DAX could be applied in Malaysia area. Thus, DAX has wide range application to research road rage.

#### 2.1.2. Driving Anger Scale

DAX measures human anger by their behavior expressions and DAS evaluates human's anger by the situations that driver is facing. Drivers' mentality is affected by different traffic situation they were facing. Driving Anger Scale (DAS) is put forward by Deffenbacher in 1994. DAS is a detailed list which contains the 53 potential items that could cause driving angry. To develop the DAS, Deffenbacher choose 724 men and 802 women from freshmen of Colorado State University to join the study. The students would face 53 potential defiant situations while they were driving and they would be required to rank the angry scale from 1 to 5 points under each situation (J. L. Deffenbacher, Oetting, & Lynch, 1994). Meanwhile, these 53 items were classified into six categories: *Hostile Gestures*, *Illegal Driving*, *Police Presence*, *Slow Driving* and *Traffic Obstructions*, and each category includes some subscales.

#### 2.1.3. Propensity for Angry Driving Scale

The purpose of developing Propensity for Angry Driving Scale (PADS) is to determine the tendency of driver continuously committing dangerous driving behaviors or get angry during driving. PADS developed by Depasquale in 2000 is a useful instrument to measure road rage (Depasquale, Geller, Clarke, & Littleton, 2001). The PADS contains 19 items which may make

drivers angry and each situation has four potential response options. Each option has a point, which is judged by 7 levels from very mild to very extreme. PADS is widely used to find the tendency of driver in angry driving. PADS can also be used to find the connection between anxiety and angry driving. It turned out that higher anxiety group caused more crashes than the medium and low group (Dula, Adams, Miesner, & Leonard, 2010).

#### **2.1.4. Comparison of Different Scales**

The three scales mentioned above have been widely examined by researches of road rage. For example, the reliability and adaption of DAX and DAS are tested in a French case, in which the relationship between driving anger and traffic violations are investigated (Villieux & Delhomme, 2010). Apart from the upper three classic instruments, some other instruments exist, such as Dula Dangerous Driving Index (DDDI) (Dula & Ballard, 2003), Trait Anger Scale (TAS) (Spielberger, 1999) and Perceived Stress Scale-10 (Cohen, Kamarck, & Mermelstein, 1983) to examine special various variables. For example, the DDDI was approved to be a feasible tool in identifying the drivers who are likely to have aggressive behavior in driving than general populations. The validity and internal reliability of the self-reported scale was examined to be evident (Willemsen, Dula, Declercq, & Verhaeghe, 2008).

### **2.2. Research Participants and Data Acquiring Methods**

#### **2.2.1. Research Participants**

The participants selected should cover a widely range people such as the variables of age, sexual, driving year, cultural, region, prefer speed. In most of paper, researcher may select a little more male than female, the age and driving years would from young to old age people. Some research focus on specific area or culture, so it needs to collect the data from suitable objects.

A wide range of people worked as research responders of driving anger investigation in the past researches. For example, undergraduate volunteers who have got the driving licenses at the University of Rouen were surveyed to examine if the driving angry inventory is suitable for people in France (Villieux & Delhomme, 2010). Hierarchical multiple regression model was used in the research and it turned out that for French people, demographic variables including gender does not have a strong relation with aggressive driving.

A self-reported evaluation based on DAS was also carried out in Ukraine, which aimed at evaluating the relation between trait and state anger. Wickens et al. (2015) attempted to figure out if people with childhood conduct disorder will cause road rage when they grew up. They selected the 5230 research objectives who claimed driving a vehicle in the past one year, and they checked the data from Centre for Addiction and Mental Health about their mental health condition. The result suggests that childhood CD would significant increase the frequency of road rage.

People of different income levels, which represented the level of work stress, were chosen as research object in Australia and basic information about each household were collected. It turned out that the driving anger was positively related to effort-reward imbalance. In addition, Australia drivers were reported to be less aggressive in driving than American but more than the British (Hoggan & Dollard, 2007). Sârbescu et al. (2014) conducted a research on whether different cultures, which included Serbia and Romania, would affect road rage. The research sample included 334 Romanians and 376 Serbians. Each sample has male and female participates with age ranges of 19 to 60 years and 19 to 57 years, respectively.

DAX questionnaire were given out to psychology students of University of Deusto in Spanish to find whether age and gender are very important to aggressive driving and multivariate analysis of the variance (MANOVA) were used. And the result told that there is no significant interaction between age and gender in predicting the aggressive driving (Herrero-Fernández, 2011). Similar to the research in Spain, a survey conducted in China also put emphasis on gender and age. No significant difference was found for male and female drivers in aggressive driving. However, people with young age will have more aggressive expression (Ge, Qu, Zhang, Zhao, & Zhang, 2015).

### 2.2.2. Methods in Acquiring Data

Questionnaire mainly based on the DAX, DAS and PADS is a useful way to collect the driving behavior of drivers, which can be used to find the relationship between the driving anger and driving behavior. Many researchers have done this work through different ways. They collected the data through telephone, email, forum, and interview, which will be introduced as follows.

A repeated telephone survey is conducted by The Center for Addition and Mental Health (CAMH) of Ontario on the adults aged 18 and above. The aim of the telephone survey is to examine if gender plays an important role in moderating the relationship between demographic factors and self-reported driver aggression and the outcome proved that gender did not (Wickens et al., 2012). Meanwhile, another survey conducted by CAMH aimed at finding if driving exposure and vehicle factor is high related to driving anger. It is reported that high exposure of driving on busy road and higher performance vehicles will lead to more frequency aggressive driving (Smart, Stoduto, Mann, & Adlaf, 2004). Similar way in collecting the data about exploring the possibility that the driver who carry firearm will lead to hostile driving behavior were carried out in Arizona. It turned out that carrying a gun will increase the possibility of illegal driving behavior (Miller, Azrael, Hemenway, & Solop, 2002).

A mailed survey was given out to participants to evaluate whether gender will lead to the difference in aggressive driving. Hierarchical regression analysis was used to evaluate if gender factor played the role of moderator. It proved that men will involve in more traffic accidents and have no obvious difference in driving anger (Lonczak, Neighbors, & Donovan, 2007). For the investigation done by Berdoulat, Vavassori, and Sastre (2013), 38.8% of volunteer filled the self-reported questionnaire based on Driving Angry Scale. Meanwhile, the rest of the responders were adults received the electric questionnaire through different network forums. Sârbescu et al. (2014) collected Romanian data by the snowball sampling technique through Facebook and arranged students distribute questionnaire to 5 participants for one year. The Serbian data was collected by mail. Participants will received questionnaire and send back with anonymity.

The impact of personality on driving behavior were researched by Yang, Du, Qu, Gong, and Sun (2013) through a questionnaire which was given out to Chinese drivers aged twenty to fifty. These drivers were interviewed about these questions based on the questionnaire. The outcome of the regression model used in the research proved that the personality of drivers is highly related to the aggressive driving behavior and involved accidents.

## 3. DRIVING SIMULATION METHOD

### 3.1 Introduction of Driving Simulation Method

Driving simulation is using PC-based apparatus to create a virtual circumstance similar to

real world for drivers. It is an effective method to analyze driving behavior because driving scenarios can easily be set and driver's actions are recorded accurately. Applied in road rage study, driving simulation has advantages in terms of avoiding dangerous situations which might be caused by road rage behaviors on actual roads.

### 3.2 Examples of Driving Simulation Method

A completed experiment can be accomplished by using driving simulation. Chai and Zhao (2016) investigated road rage behaviors of higher and lower aggression drivers by conducting a driving simulation experiment. The whole procedure of the study includes participant recruitment, self-reported measurement, driving simulation experiment, measurement, and data analysis which is a typical process. In their research, the driving simulation is composed of three sections, practice, non-provoked conditions/events, and provoked conditions/events. Practice section is for drivers to get familiar with the simulation apparatus and different road events. Non-provoked and provoked events are decided by different types of drivers and pedestrians and function as independent variables. The target of the simulation research is to analyze drivers' aggression at pedestrian crossing at unmarked roadways. They collect the participants' minimum driving speed, lateral distance from a simulated pedestrian, lateral deviation, and subjective measures to identify if the driver has road rage behaviors. The results suggest that higher aggression drivers be more prone to get involved with road rage and fail to give way for pedestrians and drive closer to pedestrians. Typically, driving simulation procedure is composed of practice/familiarization, unprovoked/general and provoked/manipulation sections, but detailed situation is varied according to different research objectives. Stephens (2011) conducted a driving simulation experiment to figure out whether events prior to circumstances might cause road rage in an unprovoked situation. They configure situations with speed impedance from enforced following of a slow vehicle or time pressure. The results suggest that sometimes circumstances have bigger impacts than events on road rage (Stephens, 2011).

Driving simulation can also be combined with other research methods. For example, Gidron, Slor and et al use the results of indirect measure and simulated driving to support the effectiveness of each other. By simulating social pressure in a 5-minute simulated driving, they measure driving behavior indices and found out that psychological inoculation reduces road rage behaviors and accidents (Gidron, Slor, Toderas, Herz, & Friedman, 2015a). Danaf et al. (2015) develop a hybrid choice-latent variable model of aggressive driving and apply it to driving simulation. In a simulation experiment, 3 of 9 intersections are set with treatment intersections and three frustrating events are allocated among them. The simulation results proves direct dependence of state driving anger on trait anger (Danaf, Abouzeid, & Kaysi, 2015).

### 3.3 Evaluation Of Driving Simulation Method

However, driving simulation has some disadvantages. The biggest issue is the difference between simulated circumstances and real world, which influences the external validity of simulation studies. The latter one is often much more complex. Additionally, the amount and usage of driving simulator or simulation apparatus is very limited, making studies more difficult.

## 4. CASE ANALYSIS METHOD

### 4.1 Introduction Of Case Analysis Method

Case analysis method is to analyze cases or projects which have existed. The most important feature of this research method is the secondary data. Many communities and associations about traffic safety will do related researches and obtain mass data; consequently, analyzing cases conducted by them can ensure the abundance and completeness of data. As a horizontal research method, case analysis can reveal more general research findings.

### 4.2 Examples Of Case Analysis Method

As mentioned in the preceding part, Dula Dangerous Driving Index is a widely-used instrument to identify rage driving (Willemssen et al., 2008). To test the reliability and validity of the index, Willemssen et al. (2008) investigated data from three samples which participated in different projects. The first program was a driver improvement program targeting at sorts of traffic offences at the Belgian Institute for Road Safety. The second project was an analysis on personality and driving. The third program was conducted by National Institutes of Health to reduce negative emotional driving. It was observed that traffic offences, driving and personality and emotional driving are all related to dangerous driving and road rage. Case analysis can also be taken in another way if trend in road rage is needed to be found out. Mann et al. (2005) take samples from a repeated cross-sectional telephone survey conducted by Centre for Addiction and Mental Health (CAMH) Monitor. Results of logistic regression reveal a decrease (from 47.5% in 2001 to 40.6%) in road rage victimization and stability in road rage perpetration from 2001 to 2003 (Mann, Zhao, & Stoduto, 2005).

Case analysis method is widely used in terms of road rage fatality and injuries. Penn and Bloom (2000) reviewed case files recorded by the Marion County Medical Examiner (MCME) during 36 years and select five typical cases of fatal road rage for further analysis. Cases of road rage have similarities of alcohol, weapons, and vehicles. What can be learned from these cases is that psychological autopsy should be applied to road rage interventions (Penn & Bloom, 2000). Mann (2002) summarized road rage cases in Canada and find out that the most common injuries are results of beating with clubs, fist or bats (Mann, 2002).

### 4.3 Evaluation Of Case Analysis Method

Concentrated analysis of cases will result in further understanding of a certain pattern of road rage. For example, fatal road rage (Penn & Bloom, 2000). Better clarification of factors' influences to road rage can be achieved, too. On one side, integrating cases can add value to the original data. On the other side, however, heterogeneity of cases is a limitation, which will affect the conclusion researchers will draw from the cases. Furthermore, knowledge might be limited in the cases selected.

## 5. FIELD EXPERIMENT METHOD

### 5.1 Introduction Of Field Experiment Method

It is universally recognized that experimental method is an important research method. There are many factors related with road rage, involving demographic parameters of drivers, psychological traits, road circumstances and events. Researchers can concentrate on the target

factor by designing suitable field experiments. Field experiment method consists of two types, observational experiments and experiments obtaining experimental manipulations of participants and data records.

## 5.2 Examples Of Field Experimental Methods

Observational study is one kind of field experiment. Observers record and collect data from people in selected sites. Shinar and Compton (2004) conducted a road observational experiment of aggressive driving behaviors. They record about 2000 behaviors and an exposure sample of 7,200 drivers for more than 72 hours at 6 sites (roads). Road rage behaviors include cutting across a single lane, honking, cutting across multiple lanes and passing on the shoulders, while the recorded attributes of drivers are gender, perceived age, presence or absence of passengers in the car, perceived vehicle status, vehicle type and period of observation. Conclusions are that, men are more prone than women to get stuck in road rage; people younger than 45 are less likely to commit rage driving; the presence of passengers slightly but consistently reduces aggressive behaviors (Shinar & Compton, 2004). In addition to statistical analysis methods, data collected from observational experiment can also be used to formulate behavioral model. To model road rage behavior, Kaysi and Abbany (2007) collected the traffic volume, genders and rage driving behaviors of drivers at an unsignalized U-turn intersection. The data set was used to work out a binary probit model to forecast whether a driver will be aggressive. Primary conclusions reveal that age, car performance, and average speed on the major road are the major determinants of aggressive behavior (Kaysi & Abbany, 2007).

Different from observational experiments, many field experiments obtained experimental manipulations. This paper takes a classical road experiment conducted by Doob and Gross (1968) as an example. In order to figure out the relationship of frustrator status and honking, which belongs to road rage behavior, they stop either an old (low status) or a new luxury (high status) vehicle at an intersection to effectively blocking subsequent cars' passage. Results indicate that, in the low status station 84 percent of the subjects honked at least once, whereas in the high status condition only 50 per cent of the subjects honked. Manipulation methods are not limited. Dukes et al (2001) study impacts of aggressive driving and driver traits on road rage. They show 144 undergraduates a packet containing two vignettes which separately describe illegally changing line (active- aggressive) and travelling below the speed limit and ask them 14 items from DAS consequently. They find out that active-aggressive, is 14% greater with road rage than passive-aggressive (Dukes, Clayton, Jenkins, Miller, & Rodgers, 2001).

## 5.3 Evaluation Of Field Experimental Method

Flexibility is a very advantageous feature of the field experiment, because the procedures and factors are determined by researchers based the research objectives. Furthermore, compared to surveys, data collected from field experiments are more close to real situations because of the avoidance of subjective perception bias. Thus, data collection is an essential part of field experiments. General data collection methods are video recording, audio recording and manual recording. An issue of field experiment is extensive data collection processes needed to enhance the results and conclusions of experiments (Kaysi & Abbany, 2007). Another problem is that, subjects may consciously attempt to present themselves in a favorable manner in a field experiment, so their reactions may be affected by the measurement process itself. One solution is to collect data from people who are unaware that they are subjects participating in an experiment (Doob & Gross, 1968).



## 6 SUMMARY OF RESEARCH METHODS

Road rage has been a worldwide problem and has drawn attention of many researchers. The rationale of road rage involves drivers, vehicles, road conditions and circumstances. As a result of the comprehensive factors which have effects on road rage, researchers often have variable research objectives and use different methods.

Driving Anger Scale (DAS), Driving Anger Expressing Inventory (DAX) and Propensity for Angry Driving Scale (PADS) are three of the most widely-used measurement tools of road rage, or driving anger. The three tools focus on driving situation, driving behavior and tendency of road rage, separately. The first method, questionnaire survey method is based on these inventories. Questionnaire survey can get extensive data, and statistical analysis of the data can reveal the regulations which researchers try to figure out. Nevertheless, questionnaire survey also has limitations. Answering questions is sometimes subjective and not consistent. The second method is driving simulation, a PC and machine based method. Despite a simulated situation cannot be totally the same as real circumstances, driving simulation is still an effective method to analyze driving behavior because driving scenarios can be set very similar to real world and driver's actions are recorded accurately. Case analysis is the third method to be introduced. The benefits of case analysis are more general conclusions which can be drawn from a list of cases. On the other hand, the defect is also about cases because knowledge might be limited in the cases selected. The final method is field experiment method. Real and reliable data can be acquired from field experiments direct at research objectives. However, collecting extensive data might be costly and difficult.

## 7. CONTRIBUTION AND PROSPECT

This review paper aims at providing a general overview of research methods of road rage so that readers can select a suitable one according to their objectives in the later research. Beyond the methods mentioned above, there are also other methods which are not widely used but worthy to be explored further. Video and image processing is an example. Automobile data recorder or road monitors are popularized these days, and useful information will be dug out by processing these data. Another method is driver-following method. Researchers can sit in a car and record a driver's behaviors. This paper qualitatively analyzes research methods of road rage, and quantitative analysis can also be conducted using meta-analytic techniques (Nesbit, Conger, & Conger, 2007).

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