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College Students' Cognition and Attitude Towards Connected and Autonomous Vehicles in China: an Exploratory Study

Wei LI[1], Tian'ai LI[2], Yongying MENG[3], Xuecai XU[4], Zhifeng MA[5]

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[1] wei21wei@hust.edu.cn, Huazhong University of Science and Technology, School of Education
[2] lta1998050@163.com, Yancheng No.1 Primary School
[3] 1950322543@qq.com, Lunjiao Peijiao Primary School
[4] Corresponding author, xuecai_xu@hust.edu.cn, Huazhong University of Science and Technology, School of Civil and Hydraulic Engineering
[5] mazf@hust.edu.cn, Huazhong University of Science and Technology, School of Education

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ABSTRACT

This study intended to explore college students' cognition and attitudes towards connected and autonomous vehicles (CAVs) in China. A comprehensive questionnaire was designed and distributed in Mainland China, and after collecting and processing the data, Bayesian multivariate analysis was presented to evaluate the six dimensions of cognition, consciousness, safety, privacy, liability, education and acceptance. By analysing each dimension, the results show that gender and status are significant for consciousness, safety, privacy and education, but location plays a significant role in safety and liability. It is found that each dimension reveals a specific thought of college students, and the potential users' cognition and attitude should be paid more attention to. Some empirical suggestions are presented to enhance the systematic improvement of CAVs and possible ethics issues.

KEYWORDS

connected and autonomous vehicles; college students; cognition; attitude; Bayesian multivariate analysis.

1. INTRODUCTION

With the accelerated development of the connected and autonomous vehicles (CAVs) technology, this field is becoming a strategic highland for a new round of technological and industrial revolutions, and it has also ushered in a golden age for the development of CAVs in China. The CAV system is an important component of the intelligent transportation systems and one of the core elements of building a green and low carbon society. These technologies are designed to improve mobility, safety, comfort and energy loss while reducing gas emissions [1]. Research shows that the CAVs can prevent a significant number of vehicle collisions, and effectively alleviate traffic congestion [2], as well as saving energy loss and decreasing greenhouse gas emissions by up to 9% [3]. The development of the CAV technology not only accelerates the upgrading of automobile products and technologies, but also has a significant impact on the future of the automobile industry, the whole industry and the value chain system of the related industries.

With the development trend of electric, connected and intelligent automobile industry, CAVs have been also strengthened rapidly in China. In December 2019, the "Draft of Development Plan for the New Energy Vehicle Industry (2021–2035)" proposed that by 2035, the L1-L3 intelligent driving system will become the standard configuration of new vehicles, and the connected vehicle rate will reach 100%, while the assembly rate of L4-L5 automated vehicles will arrive at 10%. According to market intelligence forecasts, automated vehicles will account for more than 50% of new car sales in China by 2025, and almost all new cars will be equipped with Cellular Connected Vehicle (C-V2X) systems by 2030. In order to promote the infrastructure level of smart roadways, it will lead the demonstration application and pilot operation of CAVs in the first batch of pilot cities for the coordinated development of CAVs in six cities including Beijing, Shanghai, Guangzhou, Wuhan, Changsha and Wuxi.

Since the 1970s, developed countries, such as the United Kingdom, the United States, Germany, Japan, etc., have made some progress in the study of autonomous vehicles (AVs), and Chinese researchers have also made much progress on CAVs. CAVs have great potential in improving traffic dilemma and enabling consumers to enjoy the convenience brought by this technology, especially the fully autonomous driving system, thus its deployment needs to consider the cognition and attitude of potential consumers. The attitudes of potential consumers towards the CAVs are the prerequisite for whether the CAVs can be successfully promoted in the market and recognised by consumers.

According to the National Bureau of Statistics, college students with higher education in China reached 2.4 billion by 2024 and account for 17.14% of the total population. With the rapid progress of China, the number of college students will continue to increase year by year, and by 2035 the proportion is expected to reach over 20%, hence their consumption potentiality will be enormous. As the main group of potential consumers, college students may have a positive attitude towards new technologies and new products, so it is very significant to understand their views on CAVs. Therefore, by taking college students as the research subject in China, the goal of this study is to analyse their cognition and attitude towards CAVs, so as to provide corresponding decisions and suggestions for the future development of CAVs.

2. LITERATURE REVIEW

From the psychological aspect [4], cognition and attitude include six aspects: cognition, consciousness, safety, privacy, liability, education and acceptance. Therefore, as opposed to other reviews of the CAVs with different technologies, the literature is focused on the six aspects related to cognition and attitude as follows. Due to the limited studies on the cognition and attitude of college students towards CAVs, some literature is extended to other population groups.

2.1 Consciousness-related work

Certain studies investigated the consumers' awareness of CAVs. König and Neumayr [5] collected 489 questionnaires from 33 countries with online data, showing that less than 5% of the respondents had never heard of the CAVs, and only 2% of the respondents expressed their feelings about the CAVs as "Very negative". Some scholars focus on the potential consumers' cognition and attitudes towards the CAVs. Through a comparative study, Woldeamanuel and Nguyen [6] found that compared with non-millennials, millennials had stronger support for entertainment (such as watching movies, playing games, etc.), online communication (calling and texting), working, studying and relaxing in autonomous vehicles. An online survey of 51 countries revealed that, at the individual level, young men with higher education and higher household incomes generally accepted autonomous vehicles and had a higher awareness of autonomous vehicle technology [7]. A similar study by Fu et al. [8] investigated the knowledge and attitude about autonomous vehicles and shared mobility with 643 college students from University of Alabama, Tuscaloosa, and the results showed that 97% of the students knew about autonomous vehicles, but only 41% knew about specific automation technologies, including automatic cruise control and automatic collision warning. Othman [9] made the questionnaire survey to find out the impact of the level of knowledge on the public attitude in USA. It was shown that there is a negative shift in public attitude with the increase in the level of knowledge about CAVs.

2.2 Security-related work

CAVs, some scholars believe, can communicate with other vehicles, infrastructure and pedestrians to better identify road conditions, predict upcoming events and improve transport safety, thereby increasing road traffic safety [10–12]. In the work by Woldeamanuel and Nguyen [6], 95% of millennials responded with a little and a lot of concern when asked about the absence of driver to control devices (including steering wheels, brake pedals and throttles), while 95% of non-millennials shared the same view. Through online questionnaire survey in 51 countries, Moody et al. [7] concluded that, at an individual level, young men with higher education, above-average household income and good jobs were more optimistic about the safety of AVs, whereas at the country level, developing countries in Asia (including most of Southeast Asia, China and India) as well as Brazil, Portugal and the United Arab Emirates all reported high levels of awareness of autonomous vehicles and high levels of awareness of current and future autonomous vehicle safety. A study by Maeng al. [13] about the attitudes of 1000 Korean volunteers about the information security of the CAVs indicated that users were more worried about communication failures and unauthorised personal information in mobile phones, which would greatly affect the users' willingness to pay.

2.3 Privacy-related work

In recent years, scholars have also paid attention to the privacy of the CAVs. The Internet of Vehicles (IoVs) is a powerful sensor platform that collects information from the surrounding environment and other vehicles, and then provides it to drivers and infrastructure to help secure navigation, pollution control and traffic management, as well as communication, storage, intelligence and learning capabilities to predict consumer intentions [14]. On the other hand, Bansal et al. [15] revealed that potential consumers were worried about vehicle system failures, hacking and privacy leakage. Identically, a survey on the consumers' intention of autonomous driving by Panagiotopoulos and Dimitrakopoulos [16] with adults aged 18–70 years showed that in the dimension of perceived trust, 31% of the respondents were concerned about the safety and data privacy of autonomous driving systems, while 47% of the respondents were neutral. At the same time, some studies have shown that obtaining vehicle location information is essential for the interaction between vehicles, between vehicles and the surrounding environment, as well as the provision of basic services [17].

2.4 Responsibility and right-related work

The responsibility subject, law-making, related obligations, ethics and other issues related to the CAVs are still being explored and improved. There is also controversy about whether data obtained from the CAVs can be used as legal evidence: if the driver controls the vehicle in the event of an accident, the data obtained during the operation can be used in court to determine the subject of responsibility. The ninth item of the "German Ethics Code for Automated and Connected Driving" [18] also clearly stated that in the case of unavoidable accidents, programming machines based on any difference in personal characteristics (age, gender, physical or mental health) was strictly prohibited to determine the vehicle collision object. Ryan [19] mentioned in his vision of the future transportation from 2019 to 2025 that the employment and implementation of AVs may have various moral, legal, social and economic impacts, such as autonomy, privacy, responsibility, security, data protection, etc. "Standing General Order 2021-01 | Incident Reporting for Automated Driving Systems and Level 2 Advanced Driver Assistance Systems" published by NHTSA, clearly states that NHSTA has a wide range of information collection permissions, including access to vehicle collisions, potential defects related to motor vehicle safety and compliance information, in order to timely identify and implement safety recalls.

2.5 Education-related work

On 7 May 2016, Joshua Brown collided with a vertical trailer in a 2015 Tesla Model S on the Florida Highway. On 24 March 2017, an Uber self-driving test vehicle had a traffic accident in Tampa, Arizona. In 2018, Argo AI, invested by Ford, had a traffic accident in Pittsburgh, Pennsylvania. All three accidents were caused by the driver's improper action. Therefore, the public has been increasingly concerned about how to learn about and use the CAVs. Woldeamanuel and Nguyen's [6] considered that both millennials and non-millennials cared about how to learn about and use autonomous vehicles, whereas non-millennials thought they needed time to learn how to use autonomous vehicles. Liu et al. (2020) [20] emphasised the importance of education for users and suppliers, and pointed out that both users and suppliers were required to receive education about CAVs so that terminal users can better prepare and protect themselves, passengers and vehicles from the threat regarding information and life. Some scholars also pointed out that in the training process, it was necessary to improve the drivers' awareness of road environment, attention, harm and risk perception, as well as to improve the drivers' skills and confidence in manual control of vehicles on the road. Meanwhile, different training programs for different levels of CAVs should be provided to solve the problems confronted by operating autonomous vehicles at different levels [21].

2.6 Acceptance-related work

Researchers have conducted a series of studies on the consumers' acceptance of the CAVs. Kyriakidis et al. [22] collected 5000 questionnaires from 109 countries and found that 69% of respondents believed that AVs would reach 50% of the market share by 2050, but hacker intrusion, legal and security issues would affect their acceptance of CAVs. Furthermore, an online survey of the respondents' acceptance of emerging vehicles in Austin, Texas showed that there were three main reasons that 19% of respondents were not interested in level 4 AVs: vehicle equipment or system failure, concerns about learning to use autonomous vehicles and inability to reduce traffic congestion [14]. Saeed et al. [23] found that the consumers' travel style, family, awareness of autonomous vehicle technology, consumption factors and building environment factors would affect the consumers' acceptance of CAVs. Furthermore, the potential benefits of the CAVs (reducing driver's fatigue, reducing fuel economy, driving pleasure, etc.), vehicle safety, legal responsibility and travel convenience would also affect the consumers' acceptance [24].

In summary, through the current literature about CAVs, researchers mainly investigated the consumers' cognition of the CAVs from the aspects of vehicle function, vehicle technology and demographic factors, few studies work from the perspective of psychology. As for security of the CAVs, it is found that consumers are more concerned about the safety of vehicle performance, driving safety, road safety and security of personal information. Regarding the privacy issues, the relevant literature only mentioned the collection and privacy disclosure of vehicle location information, but did not mention the attitude of consumers to the specific types of information collected. Many countries have formulated corresponding laws, regulations and ethics, which can protect and restrict the user's rights to use, and the rights and obligations of the responsible subjects involved in the machine design and programming rights of program designers to a certain extent. However, it can be concluded from the analysis that the responsibilities of all parties in the event of collision and the rights of all parties to vehicle control have not been clearly stipulated. Although some scholars consider that the CAVs can be realised, the learning time and contents of the CAVs have not been clearly stated. All the issues above could affect the acceptance of the CAVs by potential consumers. Consequently, the purpose of this study is to investigate the college students' cognition and attitude toward CAVs from the psychological aspect, and present some econometric model to evaluate the influencing factors. Based on the analysis of the literature above, and considering the current situation in China, a network questionnaire for college students was designed, mainly from the six dimensions of consciousness, security, privacy, liability, education and acceptance. The findings may provide some potential insights for the future development of CAVs.

3. DATA DESCRIPTION

In order to investigate the cognition and attitude of college students objectively, a questionnaire survey (shown in Appendix I) was designed and distributed online all over Mainland China in the period from 27 April to 15 May 2022. Within the twenty days, 3,111 responses in total were returned, and the distribution is shown in *Figure 1*. It can be seen that, with the exception of the Tibet, Hainan and Jilin Province, the college students in the rest of the provinces responded with what they thought about CAVs and relevant issues.

Among the 33 problems, the first four questions are about the personal status, including the gender, graduate or undergraduate status, majors and the locations of the students. As collected from the questionnaire, about 66.9% female and 33.1% male students participated in this survey. Among the participants, undergraduate students (including junior college) account for 89.9% while the graduate students (master and Ph.D.) account for only 10.1%. As for the students' majors, the top three who were interested in the CAVs study in the domain of education (31.3%), engineering (23.3%) and medical science (21.0%), which is why it is believed that the CAVs may bring more challenges and opportunities for them.

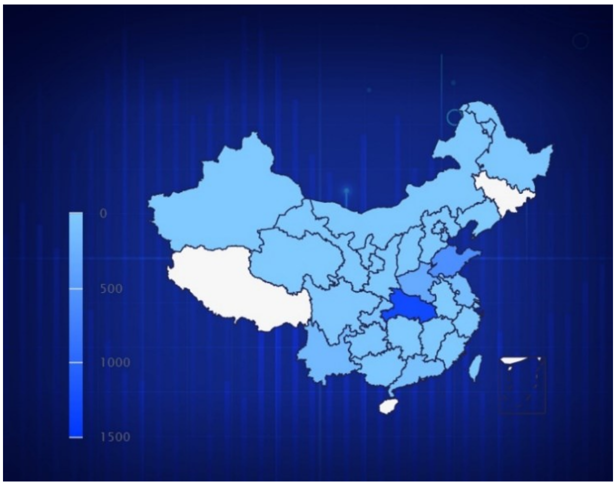

Figure 1 – Response distribution

Questions 5 to 33 address the six aspects of the college students' cognition and attitude, consciousness, security, privacy, liability, education and acceptance from different perspectives. This is followed by the three levels proposed by Eagly and Chainken [4]. Attitude here is classified as perception, emotion and action. By combining the six aspects of cognition with attitude, the details are listed in *Table 1*, in which each question reflects a different part of cognition and attitude (More details about the questionnaire are available in Appendix I).

Table 1 – Cognition and attitude classification

Cognition		**Attitude**	
	Perception	**Emotion**	**Action**
Consciousness	5, 8	6, 7	9
Safety	10, 16	11,12	13, 14, 15
Privacy	17`	18	19
Liability	20	21, 22	23, 24
Education	25, 26	27	28, 29
Acceptance	30	31	32, 33

In order to address the six aspects of cognition, all the questions obtained from the survey were digitalised and normalised as categorical parameters to be analysed conveniently, e.g. according to the administrative division in China, the locations are categorised in four parts – the Northeast area (1), Central area (2), Eastern area (3) and Western area (0), in order to find out whether the students in the Eastern area are more open-minded in accepting the advanced technologies than those in other areas; similarly, the consciousness degree is classified in five levels from 1 to 5 as "not at all concerned" to " extremely concerned" so it can be considered as an ordinal variable. In total, there are 33 parameters to be involved in the completed dataset.

4. METHODOLOGY

After data cleaning, 3,107 valid observations were obtained. As stated above, most of the parameters are categorical variables, and digitalised with an ordinal feature, so the dependent variables include six aspects of cognition, consciousness, security, privacy, liability, education and acceptance, each of which is classified as ordinal. In order to accommodate the six aspects of cognition simultaneously and possible correlation among them, a multivariate regression model is developed to express the relationship between cognition and attitude.

The general form of multivariate regression models can be extended from multiple regression models where relationships between p responses and a set of k explanatory variables are constructed as follows:

$$\begin{aligned} Y_1 &= B_1 + B_{11}X_1 + B_{21}X_2 + \cdots + B_{k1}X_k + \epsilon_1 \\ Y_2 &= B_2 + B_{12}X_1 + B_{22}X_2 + \cdots + B_{k2}X_k + \epsilon_2 \\ &\vdots \quad \vdots \qquad \cdots \qquad \vdots \qquad \vdots \\ Y_p &= B_p + B_{1p}X_1 + B_{2p}X_2 + \cdots + B_{kp}X_k + \epsilon_p \end{aligned} \tag{1}$$

By integrating the set of equations above, the multivariate regression form can be expressed as follows:

$$Y = BX + \in \tag{2}$$

where Y denotes n×p matrix in which n is the sample size, X denotes n×(k+1) matrix, B are coefficient matrix, and ∈ is n×p matrix error terms with $E[\in_i]=0$ and covariance $(\epsilon_i, \epsilon_j) = \epsilon_{ij}I$, for i, j=1,2,…m, which reflects the dependence between response variables.

In order to illustrate the model specification via ordinal variables in this study, the ordinal feature of response variable Y_i^* for observation i is described as follows:

$$Y_i^* = j, \text{if } u_{i,j-1} \le Y_i^* \le u_{i,j} \tag{3}$$

where j (j=0,1,2…,J) represents the cognition (e.g. consciousness degree, safety level, etc.), $u_{i,j}$ is estimated thresholds, and $u_{i,0} = -\infty$ and $u_{i,J} = +\infty$. The threshold values can distinguish the various cognition categories, for instance the acceptance levels j=0, 1, 2, 3 respectively, for unacceptable, partial acceptable, acceptable and fully acceptable.

The probability of an observation *i* being the j^{th} acceptance level can be expressed as follows:

$$\begin{aligned} P(y=0) &= \Phi(-\beta_i X_i) \\ P(y=1) &= \Phi(u_1 - \beta_i X_i) - \Phi(-\beta_i X_i) \\ P(y=2) &= 1 - \Phi(u_1 - \beta_i X_i) \end{aligned} \tag{4}$$

In analysing the multivariate categorical data, the Bayesian approach can be considered due to the advantages over likelihood-based estimation methods: no large sample is required to obtain estimates of posterior distributions, informative or non-informative prior distribution works, and mixed categorical or continuous outcomes can result in straightforward and efficient computation. Therefore, the Bayesian Markov Chain Montel Carlo (MCMC) algorithms are selected to obtain estimates of the proposed multivariate ordered probit regression models. A more detailed estimation procedure about Bayesian multivariate ordered probit model can be found in O'Brien and Dunson (2004) [25], Edara and Chatterjee (2010) [26], and Hobert et al. [27].

5. RESULTS AND DISCUSSION

Before the proposed model estimation, the correlation test was conducted to avoid the multicollinearity among the independent variables. The test results show that the No.14 is highly related to No.16, while the intelligent decision-making of No.19 is highly related to roadway and environment data of No.19, so they are not adopted at the same time as the independent variables.

As stated in the modelling, multivariate ordered probit model within the Bayesian framework was developed to evaluate the correlation between response variables. *Table 2* gives the estimated results, and 95% confidence intervals for statistically significant variables obtained from software STATA 16.

Table 2 – Estimation results of the proposed model

		Attitude	
	Mean	Std. dev.	95% cred. interval
Consciousness			
Gender	0.362	0.019	(0.325, 0.399)
Status	0.048	0.016	(0.017, 0.081)
No.6			
Commuting	-0.077	0.016	(-0.111, -0.044)
Family trip	-0.079	0.014	(-0.1307,-0.051)
Self-travel	-0.068	0.011	(-0.090,-0.045)
No.7			
Manipulation	0.110	0.019	(0.072, 0.149)
Automation	-0.073	0.020	(-0.111, -0.034)
No.8 Knowing degree	0.554	0.013	(0.530, 0.587)
No.9			
Remote control	0.116	0.025	(0.059, 0.163)
Automatic parking	0.086	0.018	(0.050, 0.123)
Audio control	-0.051	0.022	(-0.094, -0.007)
Moveable Wi-Fi	0.033	0.009	(0.010,0.049)
Automatic adjustment according to the environment	0.131	0.021	(0.089, 0.176)

No.10			
Reduce accidents	0.060	0.013	(0.038,0.083)
Travel conveniently	0.094	0.023	(0.048, 0.138)
Alleviate congestion	0.074	0.019	(0.033,0.107)
Energy saving, cost reduction	0.079	0.011	(0.058,0.106)
Emission reduction, environment protection	0.101	0.019	(0.059,0.137)
Constant	0.921	0.021	(0.878, 0.961)
Safety			
Gender	-0.096	0.025	(-0.144, -0.035)
Status	-0.061	0.010	(-0.075, -0.036)
Location	0.060	0.007	(0.046, 0.073)
No.11			
Slow reaction or malfunction	0.075	0.021	(0.031, 0.118)
Misjudge the environment	-0.099	0.027	(-0.153, -0.046)
No.12			
Driving habit	-0.087	0.018	(-0.124, -0.525)
New technology	-0.036	0.016	(-0.069,-0.004)
Relevant laws and regulations	-0.153	0.030	(-0.209, -0.091)
Information security	-0.059	0.024	(-0.107, -0.010)
No.13			
Labour market demand reduction	0.091	0.021	(0.048, 0.132)
New crime occurrence	0.063	0.024	(0.019, 0.114)
Extra risk increasing	0.123	0.016	(0.089, 0.155)
No.15 On-road running	0.176	0.011	(0.154, 0.199)
No.16 Degree of environment risk concern	0.277	0.014	(0.248, 0.305)
Constant	2.097	0.032	(2.037, 2.159)
Privacy			
Gender	-0.313	0.015	(-0.344, -0.286)
Status	0.045	0.019	(0.006, 0.082)
No.18 Willingness to entrust	0.071	0.017	(0.038, 0.104)
No.19			
CAV manufacturer/operator			
Social relation	0.061	0.030	(0.001,0.121)
Owner/driver personal status	0.115	0.025	(0.065, 0.166)
Personal location information	0.093	0.017	(0.058, 0.130)
Smart decision data	-0.077	0.023	(-0.122, -0.028)
Environment & roadway data	-0.138	0.016	(-0.171, -0.105)
Entertainment & exchange information	0.271	0.021	(0.228, 0.314)
Traffic management department			
Vehicle information	-0.108	0.030	(-0.169, -0.054)
Smart decision data	-0.088	0.021	(-0.129, -0.047)
Remote control data	0.131	0.021	(0.091, 0.171)
Entertainment & exchange information	0.136	0.035	(0.066, 0.204)
No. 20			
Issue data security related laws and directions	-0.055	0.022	(-0.103, -0.013)
Strengthen monitoring and establish data security evaluation and protection system	0.048	0.016	(0.014, 0.080)

Fine the privacy intrusion behaviour seriously	0.207	0.023	(0.162, 0.252)
Constant	3.106	0.025	(3.054, 3.156)
Liability			
Status	0.028	0.007	(0.013, 0.043)
Location	-0.009	0.004	(-0.019, -0.001)
No.21			
Vehicle insurance company	0.041	0.005	(0.030, 0.052)
Artificial intelligence developer	0.032	0.011	(0.009, 0.057)
No.22			
Driver	0.028	0.013	(0.003, 0.053)
No.23			
Driver			
"Protect inner passengers" or outsiders decision	0.027	0.011	(0.005,0.049)
Vehicle dynamics control	-0.038	0.010	(-0.061, -0.018)
Driving role transition	0.025	0.010	(0.003, 0.044)
Know owner information	-0.054	0.006	(-0.066, -0.042)
Owe travelling data	0.063	0.009	(0.044, 0.081)
No.24			
Network operator			
Vehicle dynamics control	-0.043	0.006	(-0.055, -0.031)
Traveling route selection	0.040	0.015	(0.011, 0.0672)
Know driver information	-0.029	0.007	(-0.045, -0.015)
Owe travelling data	-0.039	0.014	(-0.067, -0.013)
Vehicle remote control	-0.028	0.008	(-0.047, -0.013)
Traffic management department			
Traveling route selection	-0.035	0.004	(-0.042, -0.028)
Know owner information	0.031	0.010	(0.013, 0.051)
Constant	0.427	0.016	(0.391, 0.455)
Education			
Gender	0.140	0.045	(0.061, 0.228)
Status	-0.153	0.031	(-0.210, -0.085)
No.25 Attitude to driver license cancelling	0.203	0.020	(0.162, 0.242)
N0.26 Education knowledge	0.608	0.023	(0.560, 0.655)
No.28			
Knowledge of safe driving	-0.699	0.034	(-0.767, -0.632)
Knowledge of self-driving	-0.360	0.041	(-0.444, -0.278)
Specialty operation skill	-0.291	0.047	(-0.391, -0.206)
Control skill of emergent takeover	-0.453	0.041	(-0.530, -0.369)
No. 29 Acceptable longest education hours	-0.051	0.018	(-0.087, -0.015)
Constant	1.469	0.084	(1.299, 1.632)
Acceptance			
No. 31 Possibility to purchase with accident reduction and possible hacker and info leakage	0.534	0.013	(0.508, 0.561)
No. 32 Possibility to purchase with equable price	0.103	0.017	(0.072, 0.137)
No. 33 Possible price accepted	0.075	0.011	(0.052, 0.097)
Constant	0.997	0.079	(0.843, 1.151)

Goodness-of-fit			
Correlation between consciousness & safety	0.634		
Correlation between privacy & liability	0.202		
Correlation between education & acceptance	0.576		

In *Table 2*, it can be seen that the six aspects are influenced by various factors from the questionnaire. Firstly, consciousness is significantly impacted by gender, status, partial factors from No.6 to No.10. The positive coefficient of gender indicates that the male students are more likely to have consciousness about the CAVs compared to the female college students. The status is positively significant to consciousness, meaning that the higher degree the college students have, the stronger the consciousness about the CAVs is. In No.6, commuting, family trip and self-travel are significant for consciousness, but all three are negatively correlated, implying that the three may not help to increase the consciousness about the CAVs. In No.7, manipulation and automation are high concerns regarding the consciousness, but the former is positive while the latter is negative, which indicates that manipulation may help increase the consciousness whereas automation may not since the CAVs are supposed to be automatic and even autonomous.

In No.9, all the significant variables are positive besides audio control. All the functions, e.g. remote control, automatic parking, moveable Wi-Fi, and automatic adjustment according to environment, may benefit the consciousness of the CAVs, but the audio control may not be the main option due to the easy realisation. In No.10, the positive values of coefficients, e.g. reduce accidents, travel conveniently, alleviate congestion, save energy and decrease the emission and protect environment, all increase the consciousness because those features are expected by CAVs.

As for the safety dimension, gender and status of college students are negatively associated with safety while location is positively related. This indicates that the female students care more about safety than the male students, and the undergraduates are worried more than the graduates. Most importantly, compared to the college students in the Western and North-eastern areas, those in Central and Eastern areas are more concerned with safety. In No.11, the most worrisome threat, e.g. slow reaction or malfunction, misjudging the environment, is significant for safety. One is positive and the other is negative since the CAVs require a fast reaction and adapting to the environment as soon as possible. In No.12, all the significant factors, e.g. driving habit, new technology, relevant laws and regulations, information security, are negatively related to safety, implying that these factors restrict the safety level, which should be considered to overcome them. In No.13, labour market demand reduction, new crime occurrence and extra risk increasing are three significant variables that are the most worrisome about the CAVs. No. 15 and No. 16 give the last two significant variables for safety, in which on-road running may cause some conflicts before or after testing under mixed traffic flow condition, and a degree of environment risk concern may generate some potential safety issues.

As for the privacy issue, gender and status are significant variables, whereby the gender is negatively correlated to privacy, meaning that the female students care more about privacy than the male students, and the status is positive, implying that he graduate students pay more attentions to privacy than the undergraduates. In No.18, the willingness to entrust accompanies with the privacy is increasing. In No.19, regarding the CAV manufacturer/operator, social relation, owner/driver personal status, personal location information, entertainment and exchange information are required to be more private, whereas smart decision data, environment and roadway data are less concerning with regards to privacy. As for the traffic management department, remote control data, entertainment and exchange information should be more private while vehicle information and smart decision data is less concerning with regards to privacy. In No.20, data security related laws and directions issue may not enhance the privacy of the CAVs, whereas the two measures – strengthening monitoring and establishing data security evaluation and protection system – and fining the privacy intrusion behaviour seriously, may increase the privacy.

As for liability, status and location are positively and negatively significant, respectively, implying that the graduates take more responsibility than the undergraduates, and college students in the Western and North-eastern areas seem to be more responsible than those in the Central and Eastern areas. In No.21, the vehicle insurance company and artificial intelligence developer are expected to take more responsibilities, whereas in No.22 drivers are supposed to be more responsible. In No.23, the driver should be more responsible than the owner since only the variables related to the driver are significant, in which the typical "trolley problem", role transition and owing traveling data may increase the driver's liability during driving.

In No.24, the network operator's liability may increase due to traveling route selection, and knowing owner information increases the liability of the traffic management department, too.

As for the education aspect, gender and status are similar as the liability, indicating that male students care more about the education than the female students, and college students in the Western and North-eastern areas pay more attention to it. In No.25, the attitude to the driver's license cancelling is positive, meaning that the college students support it more at this point. Moreover, the higher the education level, the better in No.26. In No. 28 and No.29, all the variables are negatively correlated with the education levels, which reflects that the college students expect there to be fewer skills required and shorter education hours for CAVs.

As for the acceptance aspect, all the possibilities from No.31 to No.33 are positive, implying that purchasing or accepting the CAVs increases the acceptance of the probabilities. Generally speaking, most college students are open-minded and likely to accept new things, whether the accident reduction or price of CAVs.

Empirically, according to the analysis results of the cognition and attitude about the CAVs, the male college students and graduates should be given advantage in the future since they are more conscious about the CAVs, so it is suggested to cultivate the potential CAV users among them accordingly. In particular, all the expected functions and benefits of the CAVs, e.g. autonomous manipulation, automatic parking, accident reduction, energy saving and environment protection, would increase the consciousness, hence testing the CAVs should mainly focus on these functions in the future. From the perspective of safety, more focus should be given to female students and undergraduates, both regarding the actual accidents and the information security, and the related laws and regulations should be ethical so as to avoid new crime occurrence. As for the privacy concern, it is recommended to pay more attention to the CAV manufacturers/operators and traffic management departments to prevent the intrusion of the users' privacy, and corresponding policies and regulations should be provided. As for the liability issue, drivers, network operators and traffic management departments should make some compacts in advance, so that the conflicts are avoided when certain incidents happen. As for the education level, the college students require the use of the CAVs to be as easy as possible and they tend to learn as little as possible since the new generation has become accustomed to the electronics and devices, and they are prone to enjoying the CAVs as much as possible, which should be considered when designing the CAVs. If the functions and benefits of the CAVs, as well as the price, are realised, the acceptance possibility will be high, thus more attention should be paid to the functions and benefits of the CAVs to increase the acceptance.

6. CONCLUSIONS

This study explored the college students' cognition and attitude towards CAVs in China with a comprehensive questionnaire, and the Bayesian multivariate analysis was presented to evaluate consciousness, safety, privacy, liability, education and acceptance. By analysing the six aspects of CAVs, it was found that gender and status are significant for consciousness, safety, privacy and education, but location plays a significant role in safety and liability. Most importantly, each dimension reveals a specific thought of college students, and some empirical comments and suggestions are presented to enhance the systematic improvement of CAVs and to pay attention to possible science and engineering change advised by the college students, the potential users of CAVs.

Some major findings were discovered from this analysis. To the best of our knowledge, it is the first attempt to investigate the college students' cognition and attitude towards CAVs from the perspective of psychology, in which six dimensions were addressed. Another contribution is to present the econometric Bayesian multivariate analysis model to estimate the influencing factors, which provides some potential insights about cognition and attitudes of college students with regards to CAVs.

There are some shortcomings in this study. The locations of the college student where the questionnaire data were collected are not evenly distributed all over China, and some places may not be included, so during periods, the data may be more general. The proposed model mainly focuses on the correlation of six aspects of cognition – spatial features have not been considered, hence this could be a possible research topic in the future. Another consideration is that it is worthwhile to try out different data sources to confirm the findings and transferability of this study in future work.

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中国大学生对智能网联和自动驾驶车辆的认知和态度: 探索性研究

李伟, 李天爱, 蒙泳英,徐学才,马志凤

摘要

本文旨在探索中国大学生对于智能网联和自动驾驶车辆(CAVs)的认知和态度。通过在中国大陆进行综合问卷设计和调查，收集和处理数据之后，提出贝叶斯多元变量分析来评估认知的六维度，意识、安全、隐私、责任、教育和可接受性。 通过分析每个维度，结果显示性别和身份对于意识、安全、隐私和教育有显著影响，但地理位置对于安全和责任起到重要角色。研究发现，每个维度展现了大学生对 CAVs 的特定的想法，应该重视这些潜在用户的认知和态度, 而且针对性的提出一些实践建议来提高 CAVs 的系统性能和可能的伦理问题。

关键词：

智能网联和自动驾驶车辆; 大学生; 认知; 态度; 贝叶斯多元变量分析